Aviation Week

Including Space Technology

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A McGraw-Hill Publication

May 4, 1959

TRANSPORT REPORTS:

- Airline Outlook
- JT4 Turbojet

TWA Boeing 707 Over Golden Gate Bridge

Air Transport Facts and Figures

Convair and the ages we live in

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SPACE AGE • ATOMIC AGE

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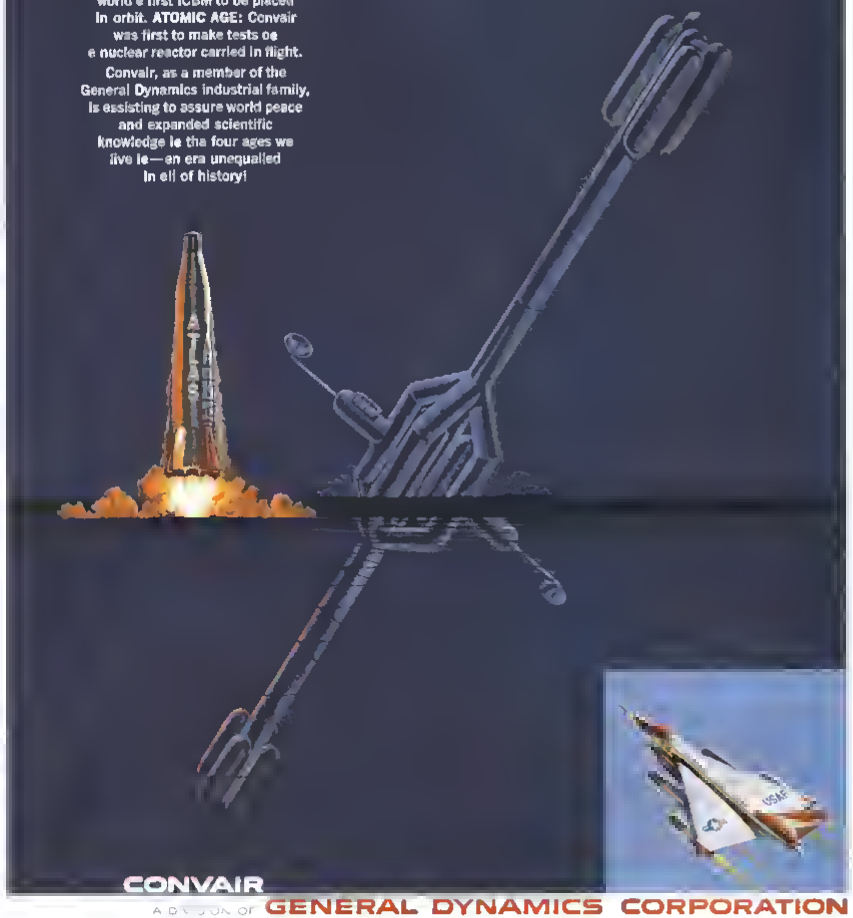

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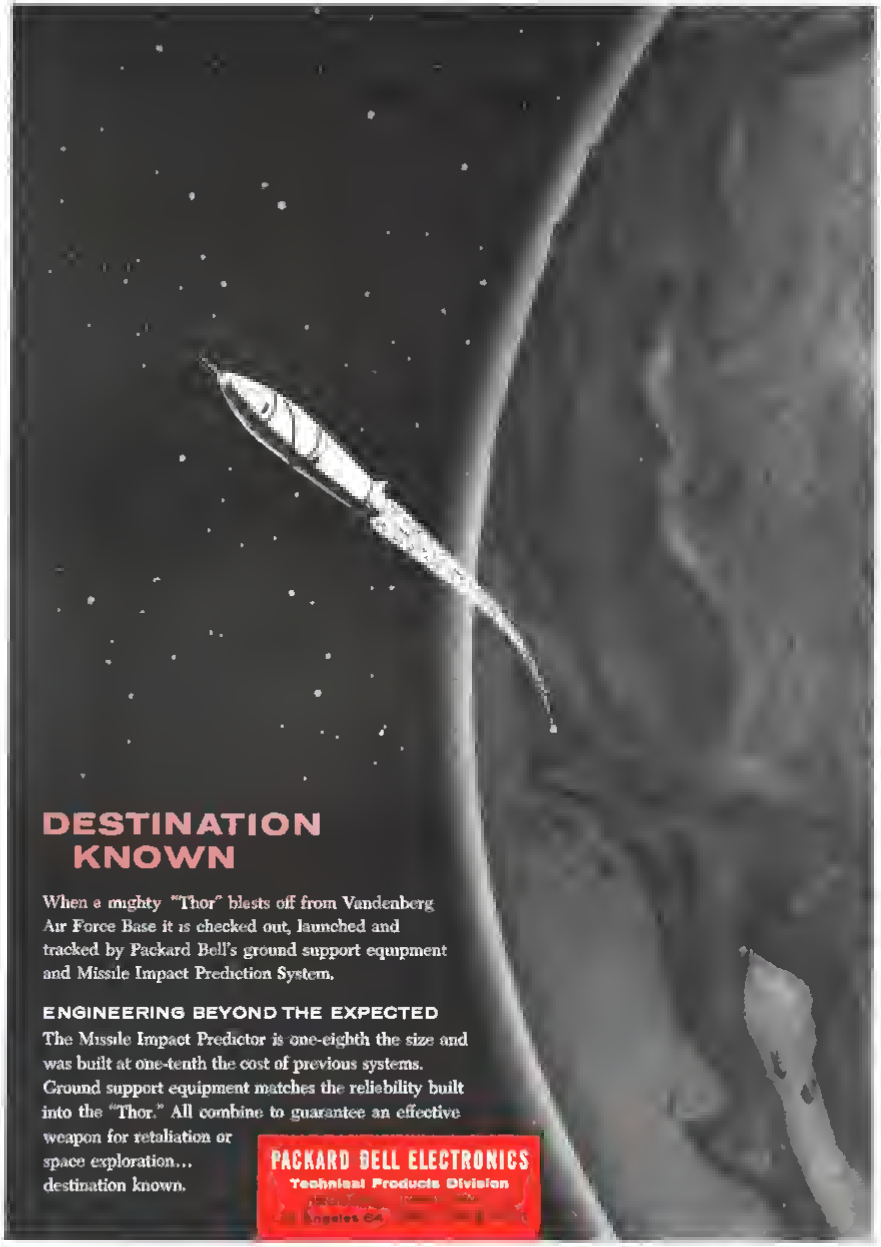

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AVIATION CALENDAR

May 9—Federal Aviation Agency's flight for pilots and aircraft owners National Aviation Facilities Experimental Center Atlantic City, N J

May 15-16—Spring Meeting Society of Aircraft Materials and Process Engineers—Eastern Division Hotel Statler, New York, N Y

May 18—Symposium on Space Medicine Electronics, Franklin Institute, Philadelphia, Pa

May 18-21—18th Annual National Conference, Society of Aeronautical Weight Engineers Hotel Henry Grady, Atlanta Ga

May 19-21—Middle Eastern District Meeting American Institute of Electrical Engineers, Lord Baltimore Hotel Baltimore

May 20-22—National Spring Meeting & Exhibition, Society for Experimental Stress Analysis, Sheraton Park Hotel, Washington D C

May 20-22—Second Jet Age Airport Conference American Society of Civil Engineers, Shamrock Hilton Hotel, Houston, Tex

May 21-22—1959 Ohio Valley Instrument and Automation Exhibit and Symposium Cincinnati Section, Instrument Society of America, Music Hall Cincinnati Ohio

May 24-June 5—Federation Aeronautique Internationale Annual Meeting, Moscow, USSR

May 25-27—1959 National Telemetering Conference on Investigation of Space, Brown Palace and Cosmopolitan Hotel Denver Colo Sponsors American Rocket Society, Institute of the Aeronautical Sciences American Institute of Electrical Engineers and Instrument Society of America

May 25-27—All Industry Production and Quality Control Exposition and Convention American Society for Quality Control Cleveland Public Hall and Hotel Sheraton-Cleveland Ohio

(Continued on page 6)

AVIATION WEEK Including Space Technology

May 4, 1959
Vol 70 No 18

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AVIATION CALENDAR

(Continued from page 5)

May 25-28—Design Engineering Show and Conference, American Society of Mechanical Engineers, Convention Hall, Philadelphia, Pa.

May 26-28—Supersonic Transport Meeting, San Diego Section, Institute of the Aeronautical Sciences, San Diego, Calif.

May 29-31—Soaring Society of America's Northeastern Soaring Meet, Dutchess County Airport, Poughkeepsie, N. Y.

June 1-3—Third Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, University Heights, Bronx, N. Y.

June 1-3—National Symposium, Institute of Radio Engineers' Professional Group on Microwave Theory & Techniques, Harvard University, Cambridge, Mass.

June 4-5—Third National Conference, Institute of Radio Engineers' Professional Group on Production Techniques, Villa Hotel, San Mateo, Calif.

June 5-6—Annual Meeting of the Army Aviation Assn. of America, Shoreham Hotel, Washington, D. C.

June 5-6—10th Annual Maintenance & Operations Meeting, Reading Aviation Service, Inc., Municipal Airport, Reading, Pa.

June 8-9—Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, Mich. Sponsor, Aero Club of Michigan.

June 8-11—Semiannual Meeting and Astronautical Exhibition, American Rocket Society, El Cortez Hotel, San Diego, Calif.

June 12-21—23rd French International Air Show, Le Bourget, Paris, France.

June 14-18—Semiannual Meeting, American Society of Mechanical Engineers, Chase Park Plaza Hotel, St. Louis, Mo.

June 16-19—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

June 21-26—Summer Pacific General Meeting and Air Transportation Conference, American Institute of Electrical Engineers, Olympia Hotel, Seattle, Wash.

June 23-25—33rd Meeting, Aviation Distributors and Manufacturers Assn., St. Francis Hotel, San Francisco, Calif.

June 29-July 1—Third National Convention on Military Electronics, Shoreham Park Hotel, Washington, D. C. Sponsor, Institute of Radio Engineers' Professional Group on Military Electronics.

June 29-July 3—Summer seminar on Plastics—Its Mechanical Properties, Design and Applications, Pennsylvania State University, University Park, Pa.

July 1-10—U. S. National Soaring Competition, Harris Hill, Elmira, N. Y.

July 30-31—Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute, Stanley Hotel, Estes Park, Colo.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.

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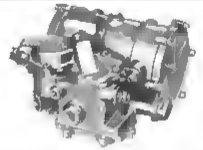
A few of Holley's Engine Accessories for Jet Aircraft

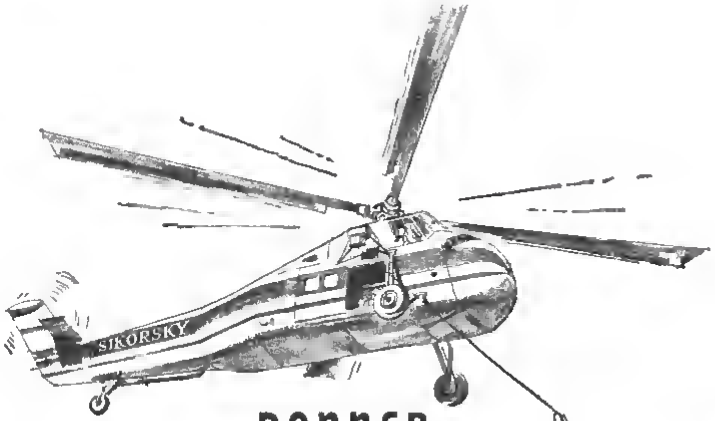
The Holley designed R-92 Compressor Bleed Governor for the Pratt & Whitney Aircraft JT-3 and J-57 Jet Engines

A companion to the actuator is the R-96 Compressor Bleed Governor for the JT-4 Jet Engine.



Designed for Pratt & Whitney Aircraft JT-4 Jet Engine, the R-98 Bleed Piston Actuator is Holley designed and manufactured.

This bleed valve and actuator for the JT-3 Jet Engine is manufactured to Pratt & Whitney Aircraft design by Holley.



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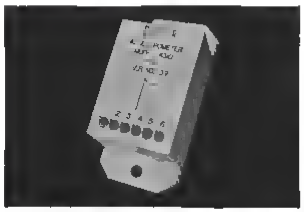

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GPL research

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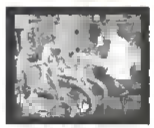

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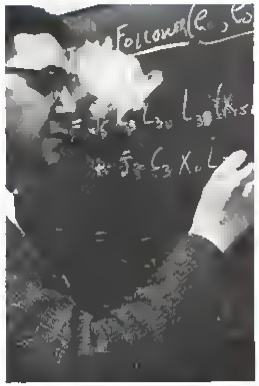
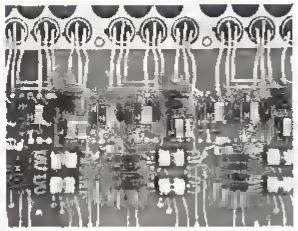
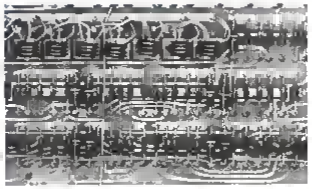
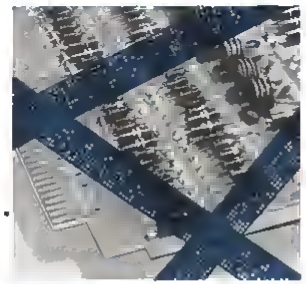
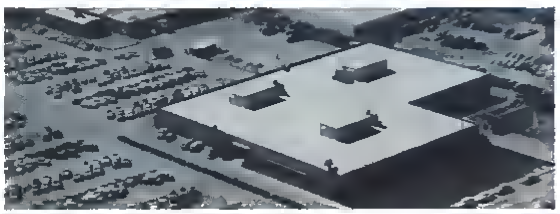






what goes into a computer system.....





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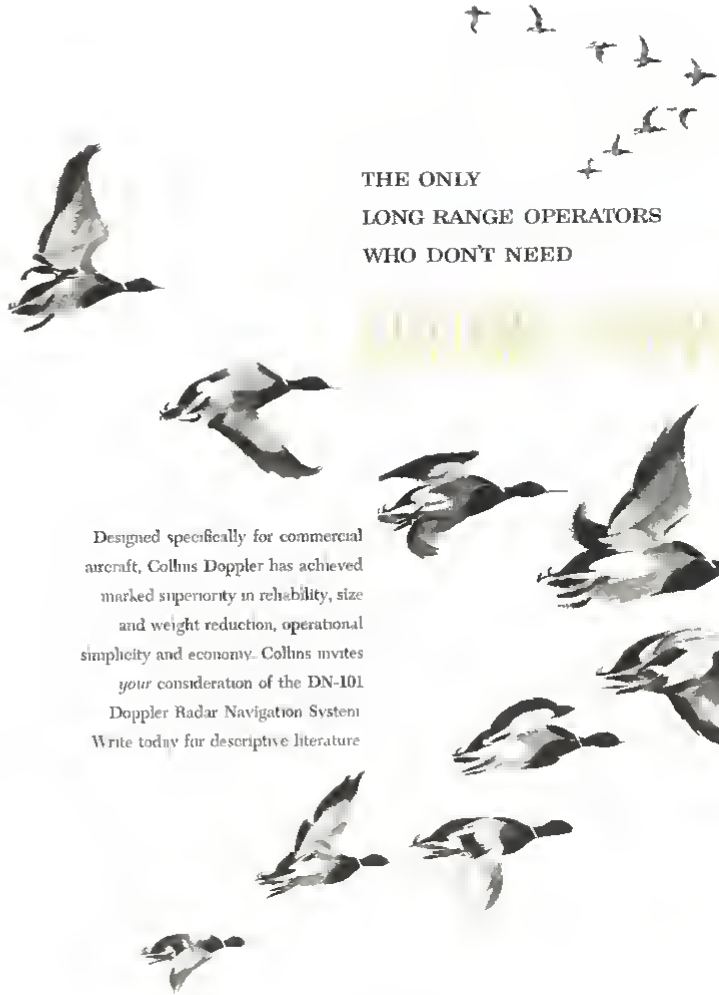

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May 4, 1959

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Including Space Technology

Vol. 70, No. 18
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COVER Trans World Airlines Boeing 707-120, flying over the Golden Gate bridge at San Francisco, Calif., symbolizes the beginning of transcontinental jet transportation. N731TW, TWA's first production 707, was delivered Jan. 29 and now is being used for pilot and maintenance training.

PICTURE CREDITS

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Fill Those Seats

Some 20 billion new seat miles must be filled on the planes of the U S domestic airlines fleet during the next three years if the promise of the jet transport age now dawning is to be truly fulfilled. Last year the domestic airline fleet offered an annual capacity of 40 6 billion seat miles. But by 1962 when the initial phase of the jet transport equipment program will have been completed this annual capacity will jump to over 60 billion seat miles, according to the best estimates available now and based on current equipment programs. From 1962 on ward the airline industry will have to sell a high percentage of these 60 billion seat miles every year.

This will pose a truly formidable challenge to the air line industry in sales, passenger service and operational techniques. Much of the initial experience with new jet transports now in service on an extremely limited basis is detailed by AVIATION WEEK's transport staff in this current issue which also contains the 20th edition of Air Transport Facts and Figures, compiled by the Air Transport Assn. But the magnitude of the problem facing the airlines with fleet-wide operations of jet transports can better be gaged by looking back at the progress achieved during the first post-war decade. In the 10-year period from 1946 to 1955, domestic airline seat capacity increased about 22 5 billion seat miles—from a total of 7 5 billion in 1946 to 30 billion in 1955. Now in the next three years the airline industry must manage an increase of almost the same magnitude as it achieved during the first 10 postwar years.

Nobody but a confirmed optimist could survive in the aviation business. Therefore we cheerfully go on record with the prediction that the airlines will handle the absorption of this additional 20 billion seat miles annually in a profitable manner by the end of 1962 and, indeed, this capacity may well turn out to be inadequate to meet the passenger demand of the mid 1960s.

But this goal will not be achieved by the well worn traditional grooves that have brought the air transport industry through the piston engined era to the threshold of jet operation. It will require fresh and imaginative thinking on all the problems from fares to traffic control, bold, fast moving management, and a far more responsive attitude on the part of federal agencies such as the Civil Aeronautics Board and the Federal Aviation Agency to the acute need of new technical and economic patterns to ensure success for air transport in the 1960s.

If allowed to operate in the proper economic and technical environment, we firmly believe that the jet transport will power the airline industry to new plateaus of traffic and profit in the decade looming ahead. If this proper environment fails to develop along with aggressive, modernized airline management, the jets can reverse this velocity factor and run an airline into the red faster and deeper than has ever before been possible.

The passenger, of course, is the key to the problem. If the jet transports give him what he wants—a fast, comfortable, reliable ride at a reasonable price—his demand will keep pace with the airlines' supply.

We already know that the jet transport has the capability of fulfilling these passenger requirements. But whether its economic and technical environment will restrict the full employment of this capability will be the acid test of the jet transport era.

We expect the jet also will sound taps for the current airline sales pitch to sell champagne and filet mignon as a rather poor substitute for schedule reliability. The speed and passenger capacity of the jets make elaborate meal and beverage service impractical even with a platoon of stewardesses. The biggest passenger appeal of the jets lies in their speed and comfort. But these can be quickly canceled if schedules deteriorate.

Responsibility for operational reliability must be shared today by the Federal Aviation Agency, with its airways and traffic control system, and by individual airlines with their maintenance standards and passenger handling techniques. Airline passengers are getting too sophisticated to swallow the bromides about unscheduled delays, nor can the full blame for this be placed on traffic control and weather. We recommend that airline executives mingle occasionally with a plane load of their passengers who have been dumped without notice due to equipment problems and listen to their realistic appraisal of various airlines' operational capabilities.

Nor can we muddle along with the same old creaking and antiquated traffic control system that has traditionally lagged a decade behind its realistic operational requirements. It will take some truly vigorous work by the Federal Aviation Agency to translate the wide variety of technical solutions to its problems already available into a high-density, all weather traffic control system right down to automatic landing capabilities.

Fares will be another key to the future growth of air line traffic. New markets must be tapped to fill the jets' capacious cabins, and the growth of lower fare, bare minimum service type of air transport is inevitable with the major increase in speed and individual aircraft capacity. We think a far more flexible fare structure than the fixed rate scale the CAB now envisions is an absolute necessity in broadening the airline market.

Specialized markets, such as commuter traffic between major population centers, also will prove to be a seat filler fat beyond its present magnitude and, of course, the vacation package tour is only in the early portion of its possible airline growth. Airlines must devise some more efficient techniques for handling their passengers and eliminating much of the annoying fuss and needless complexity they now endure in reservations, ticketing and checking in. Here again there are ample electronic and mechanical techniques already awaiting application to these airline problems.

The jet age is now dawning. Its initial experience has indicated a tremendous passenger demand and a profitable operation when high aircraft utilization rates and high load factors are combined. But this initial success of limited scale jet transport operations should not distract us from the formidable tasks that lie ahead in filling an additional 20 billion seat miles by 1962.

—Robert Hotz

WHO'S WHERE

In the Front Office

Robert W. Kerr and **Robert C. Finkelstein**, directors, Solar Aircraft Co., San Diego, Calif. Messrs. Kerr and Finkelstein are directors of Fairbanks, Morse & Co.

George F. Pew, president of Aero Design & Engineering Co., Oklahoma City, Okla., a subsidiary of Rockwell-Standard Corp., elected a director of Rockwell-Standard.

Joseph E. Otis, Jr., board chairman, Dodge Manufacturing Corp., Mishawaka, Ind. J. Allan MacLean succeeds Mr. Otis as president.

Donald C. Power, a director, Curtiss-Wright Corp., Wood-Ridge, N. J. Mr. Power is board chairman and chief executive officer of General Telephone and Electronics Corp.

G. E. Steiner, president and a director of M. C. Jones Electronics Co., Inc., Bristol, Conn., which was recently purchased by Bendix Aviation Corp. Also **Stanley T. Urbank**, vice president, general manager and a director.

James Allen, a corporate vice president and assistant to the president, Northrop Corp., Beverly Hills, Calif. Mr. Allen continues as a director.

Frank J. Reynolds, executive vice president, Stavid Engineering, Inc., Plainfield, N. J.

Fred J. Agnich, a vice president, Texas Instruments Inc., Dallas, Tex. Mr. Agnich will head the company's newly formed Geo Sciences and Instrumentation Division.

Louis H. Arieson, vice president and general manager, Davstrom Transicoil, division of Davstrom Inc., Worcester, Pa.

C. G. Baker, vice president, sales, Filtors, Inc., Port Washington, N. Y.

G. Daniel Brewer, assistant vice president, project management and marketing, Grand Central Rocket Co., Redlands, Calif. Also, **George Staley Cushman**, director of marketing.

J. W. Evans, director, and **F. H. Moore**, technical director, Advance Planning Staff, Electronics Division, Hazeltine Corp., Little Neck, N. Y. Messrs. Evans and Moore continue as assistant vice presidents of the division.

F. T. Blakey, business manager and a special director, Bristol Siddeley Engines Ltd., London, England. Frank Shutt succeeds Mr. Blakey as secretary.

Honors and Elections

Capt. **Stewart W. Hopkins**, of Delta Air Lines, has been awarded the Civilian Flight Safety Award of the Society of Daedalians for 1958. The Daedalian Award is presented annually for outstanding performance in the line of duty.

Joseph B. Elliott, president of Tele Dynamics Inc., has been named chairman of the Small Business Committee of the Electronic Industries Assn., Washington, D. C.

Earl O. Olson, manager, Duluth, Minn., airport, has been named America's outstanding airport manager of the year by the American Assn. of Airport Executives.

(Continued on page 180)

INDUSTRY OBSERVER

► Ion engine producing 40 kw. of power and 1/10th lb. thrust (AW Apr. 13, p. 28) will be tested in about two months at Lewis Research Laboratory of National Aeronautics and Space Administration. The engine with this thrust could be used for satellite attitude and orbit control. General Electric's Aviation Gas Turbine Division has been running a smaller ion engine since last October. It produces 1/100th lb. of thrust and 3 kw., weighs one pound not counting auxiliary equipment.

► Columbium is attracting new interest in high temperature application up to 2,500F for turbine buckets, wing leading edges and nose cones. Thompson Ramo Wooldridge, Battelle Memorial Institute and General Electric all are doing work on it. It is more oxidation resistant than molybdenum and is easier to alloy to improve oxidation resistance.

► Proposals in competition for a feasibility study on a one-million-pound thrust solid propellant general purpose booster are being evaluated by ARDC's Wright Air Development Center, which is expected to award a single contract, with no backup support. Proposals have been submitted by Aerojet-General, Thiokol, Astrodyne, Grand Central Rocket, United Research Corp., and Allegany Ballistic Laboratories. Specifications called for a single stage unit larger than any previous solid propellant charge. Estimates are that the configuration may be as long as 40 ft. and 8 ft. in diameter.

► Army Ballistic Missile Agency is aiming to accelerate establishment, possibly by the end of the year, of an equatorial launch site in the Pacific for its Project Saturn. Navy's Pacific Missile Range organization will assist Army in implementing requirements.

► Look for North American's Mach 3 F-108 interceptor to undergo an external configuration change despite the lateness in its development stage. Internal equipment is the cause.

► USAF is looking for a new aircraft metal or alloy that will withstand both sonic pressure and heat. In examples of sonic failure involving Boeing B-52 and KC-135 jet tanker, fatigue occurred in trailing surfaces, according to Maj. Gen. A. G. Hewitt, director of maintenance engineering and deputy chief of staff-materiel. Stopgap measure is to replace conventional 75 ST aluminum skin with honeycomb sandwich type construction, posing a complicated repair job.

► Interim reports on Study Requirement 192 for establishing a lunar base with bombardment capability will be submitted to ARDC in mid-August by North American Aviation, Aerojet General Corp., and Douglas Aircraft Corp., all of which are conducting funded studies (AW Apr. 27, p. 26).

► Air Force decision on whether to proceed with development of two or three of the ballistic missile defense systems, known as Boost-Track, proposed by nine companies during a recent three-day session at Wright-Patterson AFB is not expected to be reached quickly. Companies which made proposals include Boeing, Convair, General Electric, General Mills, Hughes Aircraft, Lockheed, Radio Corp. of America, Raytheon and Westinghouse Electric (AW Feb. 9, p. 23).

► American Bosch Arma guidance system for the USAF-Convair Atlas will not be used to guide the current D series test flights but will appear in E series tests.

► Douglas Genie MB-1 air-to-air rocket is now capable of better than Mach 4 speeds, can be delivered to North American Air Defense Command for about $7,000 each. Cost jumps to $250,000 when the nuclear warhead is installed.

► Development testing of Army's Nike Zeus is scheduled to be conducted from Kwajalein Atoll in the Pacific. Program funding now covers Fiscal 1959, 1960 and 1961.

Washington Roundup

Nuclear Plane Hearings

Rep. Melvin Price (D Ill.), chairman of the research and development subcommittee of the Joint Congressional Committee on Atomic Energy, is scheduling a two-day public hearing May 14 and 15 on the aircraft nuclear propulsion program. It will be the first public presentation on the program. The question is whether the Administration is willing to lift the budget ceiling and accelerate the program. Top Administration officials recently had an all-day briefing on the program by technical personnel working on the project at the Evendale, Ohio, plant of General Electric Co. (April 20, p. 25)

First witnesses will be Air Force officials favorable to an accelerated ANP. Maj. Gen. Donald Keirn, assistant deputy chief of staff for nuclear systems, followed by Secretary James H. Douglas and Gen. Thomas D. White.

ARPA Speculation

Speculation about the lifetime of Defense Department's Advanced Research Projects Agency continues (see p. 28). Latest version is that ARPA Director Roy Johnson will leave office when Defense Secretary Neil McElroy does, and that most of ARPA's scientific and technical personnel will then be absorbed by the relatively new Defense Office of Director of Research and Engineering, headed by Dr. Herbert York.

Improved Electronics

Officials of Air Research and Development Command and Air Materiel Command have begun a series of discussions aimed at developing improved management and organizational procedures for development of large electronic support systems. The result could be a major reorganization of Electronic Support System Project Offices (ESSPOs).

Ike Likes Subs

President Eisenhower was asked at his press conference last week what his position was on the desire by "some high Air Force officials" to gain "strategic control of the (Polaris) missile shooting submarines."

"Well, I think I would be with the submarines," the President replied. "I hadn't heard this story, this charge before. And, I would think that here is something that the Secretary of Defense could control and direct without—and coordinate without any difficulty."

BOAC's Tokyo Stop

Civil Aeronautics Board last week began grappling with the thorny issue of whether British Overseas Airways Corp. should or should not be granted a Tokyo stop on its around-the-world route (AW April 27, p. 38). Because Board Examiner Ferdinand Moran rested his recommended decision on very compelling reasons of public interest, the Board must weigh the public interest issue heavily in reaching its decision. At the same time, it must consider all international aspects of the case as it passes judgment on the bilateral obligations of both countries.

On the latter point, the Board moves into an area which the State Department presumably looks upon as its private realm. State has already stated its position clearly and unequivocably. BOAC should be granted the route and the stop. And State has reasoned to its own satisfaction that BOAC is entitled to the Tokyo stop under the terms of the Bermuda Agreement—the bilateral pact between U.S. and Britain. To wrap the case up so as to conform to the Administration's stand on the Tokyo stop—regardless of how the Board decides—State could conceivably prove to itself that failure to grant the Tokyo stop would be against the public interest because of the intricate ramifications involved in international relations between the two countries.

Glipar Contracts

Twelve contractors were selected last week from among approximately 30 bidders for the Guide Line Identification Program for Anti-Missile Research (Glipar) of the Advanced Research Projects Agency. Two of the 12 proposals accepted were from university groups, and the others were divided among aircraft, electronic, and related companies.

Contractors for Glipar will be: Aeronutronic Systems, Inc., Glendale, Calif.; Allied Research Associates, Boston, Mass.; the University of Chicago, Convair Division of General Dynamics, San Diego, Calif.; General Electric (Tempo), Santa Barabara, Calif.; General Mills, Inc., Minneapolis, Minn.; Hughes Aircraft Co., Culver City, Calif.; Industrial Research Associates, Baltimore, Md.; Thompson Ramo Wooldridge, Los Angeles, Calif.; Radio Corp. of America, Burlington, Mass.; Republic Aviation Corp., Mineola, N. Y., and Technical Operations, Inc., Burlington, Mass.

Renewed MATS Pressure

Military Air Transport Service intention to increase its own operations and buy less commercial airlift for Fiscal 1960 may bring renewed pressure for enactment of legislation to limit its worldwide operations. Commercial airlines have often criticized MATS as operating a huge airline, in direct competition to commercial carriers in many instances, and have called for greater utilization of the airlines in the carriage of military traffic. Congress last year in the appropriation bill made available $80 million to be used only to buy commercial transportation to supplement MATS. Witnesses told the House Defense Appropriations Subcommittee this year that only $66.7 million of the $80 million had been spent with commercial carriers and that only $54 million is programmed for Fiscal 1960.

'Fifth Wheel' Committee

The Civilian-Military Liaison Committee, created to "advise and consult" on aeronautical and space matters that concern the National Aeronautics and Space Administration and the Defense Department, is "strictly a fifth wheel" and "nothing more than a post office," Chairman William A. Holaday told a Senate space subcommittee.

Holaday said he is drafting proposals that would strengthen his committee's position so it can make a real contribution to the nation's space effort. The subcommittee, headed by Sen. Stuart Symington (D-Mo.), is looking for wasteful duplication in space programs. Holaday said he knows of none at the present.

—Washington staff

U.S. Airlines May Hit Record Earnings

New economic study indicates airline growth trend will parallel an increase in U. S. gross national product.

By L. L. Doty

Washington—Sharp upsurge in passenger traffic during the first quarter of the year now indicates that 1959's net earnings for the domestic trunkline industry may top the previous high of $63 million reported for 1955.

Latest forecast, an upward adjustment from the $43 million net earnings predicted earlier this year (AW Mar. 9, p. 35), is based on the recent revival of the industry's historic growth trend which came to a virtual halt in 1958. It is also based on a new economic study which shows that airline traffic peaks and valleys closely parallel upward and downward quarterly swings in the gross national product.

If the general economy holds to its upward trend throughout the balance of the year, as most economists predict it will do, revenues for the year will show one of the sharpest gains in airline history. Degree to which the climb in gross revenues will be reflected in net profits depends on the inflationary factor—the rising cost of doing business.

Trunkline Picture

Here is the general economic picture as it is related to the trunkline industry:

- **Trend toward higher revenues** under profit margin was set in the first quarter. Delta Air Lines is expected to report it carried more in the first quarter than in any other three-month period except the final quarter of 1958, when the net exceeded $2 million. United reported a $1.8 million first-quarter profit compared to a loss in the first period last year. Both Trans World Airlines and Capital made sharp cuts in first period net losses compared to last year.
- **Business travel will climb.** Close relationship of business travel to the gross national product gives strong assurances of continued growth in this travel category. The gross national product stood at $460 billion at the end of the first quarter, a 14% increase over last year and only slightly short of the $470 billion earlier predicted for December 1959. Recently, Woodlief Thomas, economic advisor to the Board of Governors of the Federal Reserve System, forecast a 5% rise in the gross national product during the year.
- **Personal travel will grow** during the year. Such travel is geared to personal income and discretionary spending power according to recent surveys. Consumer spending during the first quarter reached $300 billion at an annual rate, highest level attained for a three-month period. Treasury Department is estimating that 1959 personal income will reach $374 billion—up $20.5 billion over 1958.
- **Expansion of turbojet and turboprop** aircraft is expected to generate new sources of traffic (AW April 20, p. 39). According to American Airlines President C. R. Smith, the new equipment will "manufacture" air transportation with economy.
- **Inflation trends** appear to have been arrested at least temporarily. Airline costs will continue to climb, due primarily to interest rates on loans for new equipment and transitional costs of the turbine aircraft. However, if inflation is checked to some degree, the rise in costs may not be so marked.
- **Normal expansion of operations** will boost labor costs slightly but with most labor contracts now settled through 1960, any major strikes that would touch off a new spiral of wage levels are not expected this year. In general, labor costs, a major factor in the over-all expense level, probably will remain relatively stable throughout the year.
- **Washington observers** now feel that the 4½ cents fuel tax proposed by President Eisenhower has little chance of passing Congress this year. It has been estimated that such a tax would cost the airlines approximately $86 million in fiscal 1960.
- **Unknown factor** in the general outlook for airline business is the passenger fare issue. Most airline financial experts feel that although revenues will reach new highs this year, amounts earned through to net earnings will not be proportional unless rates are increased by the Civil Aeronautics Board.

Prospects that gross revenues for the domestic trunkline industry will exceed $1.8 billion are now bright. This would represent an increase of about 15% over the all-time high of $1.5 billion reported by the industry in 1958.

Last year, expenses also climbed to a new high—$1.4 billion. Result was a total net profit of $44 million, a decided jump over the $27 million report the previous year but far short of the earnings deemed necessary by the industry to bring about jet operations successfully and economically.

If costs in 1959 are held to a 10% increase, chances are strong that net profits in 1959 may go as high as $75 million, even without a passenger fare increase.

This estimate is based on the assumption that most carriers will continue to use the seven-year depreciation policy on new equipment. Revenues for the year are projected on the present fare level.

Adjustment in rates will have a strong effect on both revenues and earnings. For example, United Air Lines has reported that the 6½% increase granted in February, 1958, and subsequent rate revisions boosted last year's gross revenues by approximately $145 million.

Expanding Economy

The forecast also is projected on the widespread theory that the general economy will continue to expand throughout 1959. Future growth is borne out by such factors as increases in general industry's capital expenditures.

Capital expenditures, which declined steadily last year, moved from an annual rate of $31.1 billion during the first quarter to a $32.9 billion annual rate committed through the second quarter. Expenditures for plant and equipment may reach $34.2 billion by the end of the year, a 7% increase over last year.

Of chief interest to the trunkline industry is the gross national product index which is rising spectacularly. The close parallel between the gross national product and passenger revenue miles is now providing airline economists with an effective measuring tool in projecting future plans.

However, in tracing the relationship between gross national product and airline business, two deviations show up in past patterns which leave some margin for error in predicting future trends.

First deviation stems from airline strikes, major industrial strikes such as a prolonged steel strike and highly publicized midair collisions. During the past eight years airline traffic has reacted violently to such aberrations despite the status of the general economy.

For example, airline business actually fell off sharply from the gross national product index immediately following the Grand Canyon midair collision in June, 1956, although business generally was especially stable at the time.

Second deviation, which apparently has no explanation, shows that airline business dipped abruptly during the 1954 recession two months in advance of the drop of the gross national product. And it trailed the gross national product by about two months in recovering from the decline.

However, in the 1957-58 recession the gross national product preceded airline business in its decline by about two months but airline business recovered well ahead of the gross national product. Airlines are watching consumer spending as a second important index in determining traffic trends.

Generally, the trunkline industry is moving into the transition to turbine-powered equipment in a relatively strong financial position. Current ratios at the end of 1958 showed a substantial improvement over previous periods and in many instances are edging close to a healthy 2-1 ratio although CAB accounting changes contributed some artificialities to these.

Actually, working capital positions are normally stronger than corporate balance sheets indicate because of the necessity of including air travel subscribers' deposits as a current liability. Although this item is theoretically a current liability, it is, in fact, a long term liability since it is never drawn upon in significant amounts.

Eliminating the subscribers' deposits entry of $9.9 million in American's statement, for example, would give the carrier a straight 2-1 current ratio. Eastern reported a 2½ ratio. Both Western and Braniff showed strong current ratios.

Ratio of market value of common stock to book value also has improved significantly to provide carriers with a stronger base for refinancing than has previously been possible.

Last year at this time, only two airlines—American and Northeast—had common stock selling at a higher price than the book value of the stock and these ratios were only fractional. This year, according to April 28 listings on the New York and American Stock Exchanges, all but a few airlines are showing a strong ratio of market to book value of their shares outstanding.

A number of carriers can be expected to follow American's lead in taking advantage of the current economic situation for further financing. Prior to announcing its plan to take out new loans totaling $70 million, American spelled out its philosophy in this respect when the company's Executive Vice President-Finance, William J. Hogan, said:

"Many of the elements entering into future cash flow are difficult to evaluate precisely. . . . In view of such uncertainties, prudence indicates the desirability of a strong cash position and an adequate equity base. It may be, therefore, that if the security market continues on the strong side we would take advantage of the situation and obtain some additional financing, despite the fact that our entire equipment program has already been financed."

Heavy Activity

Although airline listings are recently experiencing heavy activity and irregular strength in price, such stocks are not attractive from an earnings standpoint and are considered by many traders as highly speculative. In addition, conservative brokers have indicated there is a high degree of speculative activity in the market that should be watched with caution. Keith Funston, president of the New York Stock Exchange, also has warned against uninformed speculation.

What effect these notes of warnings, if continued with increasing stress, will have on the investor remains to be seen. It is quite possible he will continue to look upon airline listings as growth stocks—particularly in view of the introduction of jet equipment this year.

The fact remains, however, that airlines must show a strong earning position if a healthy relationship between market price and book value is to be stabilized.

Progress in this direction is promising. During the first quarter Northwest Airlines recorded a first-quarter profit for the first time in its 32-year history. The company's net income of $93,564 during the period compares with a net loss of $795,000 in the first quarter of 1958.

Operating revenues climbed 44% and expenses were up only 31%. Operating income totaled $639,000—an improvement of $2.3 million over the first quarter of 1958.

Western Air Lines reported a net profit for the first quarter of $1 million. Last year, the airline suffered a four months strike that began Feb. 21 so that comparative data is unrealistic.

National Airlines showed a first quarter profit of $1.6 million—an 81% increase over net earnings of $586,000 in the same period last year. Gross revenues were up 24%. Eastern reported a $2.1 million profit for the period, despite a slow January recovery from a 39-day pilots' strike at the end of the year.

American reported a net loss of $1.9 million for the first three months and a 2% decline in revenues for the period. However, C. R. Smith, American president, estimated that revenues would have been $79 million instead of the $69.4 million had it not been for the pilots' strike early in the year.

Trans World Airlines reported an 18.6% increase in revenue and held expenses to a 6% increase for the first quarter of 1958 compared to the same

NATIONAL AIRLINES showed a 20% increase in traffic during March, began New York-Miami Lockheed Electra service April 26.

period last year. Net loss for the period was reduced to $3.7 million from the $10.4 million reported in the same period last year.

Capital cut its loss for the first quarter to $936,800 from $1.5 million in the corresponding period last year. Operating revenues climbed 13.4% while operating expenses were held to an 11.4% increase.

Delta Air Lines' revenues during the first quarter reached $27 million, a 17% increase over last year.

Cargo revenues rose 22% in the same period.

Todd G. Gole, Delta executive vice president-administration, told AVIATION WEEK that the company's revenues were "aided by passenger fare adjustments" and added: "Our overall expanded volume of business can be attributed in part to the effects of strikes experienced by several of our competitors and to the nationwide economic upturn."

The company is expected to report a substantial net profit for the first-quarter period.

Continental Airlines reported a $230,000 net profit compared to a $240,000 net loss in the first quarter last year. Expenses were up 31%, revenues climbed 38%.

Space Technology

Gen. Schriever Asks ARPA Abolishment

By Ford Eastman

Washington—Existence of Advanced Research Projects Agency threatens to delay introduction of space weapons into an operational inventory, Congress was warned by Lt. Gen. Bernard A. Schriever, commander of Air Research and Development Command, USAF.

The newly-appointed head of ARDC said he felt that ARPA, as an operating research and development agency, should be abolished at the end of the current fiscal year and that policy direction, guidance and program approval should be applied to the services by the office of Director of Research and Engineering.

Gen. Schriever also criticized the delay in assigning operational responsibility of projects under development to the services and, at the same time, he said he felt the Air Force should have the predominant role in space.

Testifying before the Senate Subcommittee on Governmental Organization for Space Activities headed by Sen. Stuart Symington (D.-Mo.), Gen. Schriever said the key factors in reducing lead time between technical feasibility and useful operational systems from an organization management and administrative standpoint, are:

- "The primary user should be designated as the operating service upon initiation of a weapon system development program and should be assigned management control of both development and operation of the system.
- "Proper relative priority should be maintained between military and non-military projects.
- "Proper integration and control of military and non-military scientific efforts and resources should be assured.
- "Mission areas for each of the services should be clearly defined.
- "The service responsible for system development should be delegated clear authority and should be given the resources necessary to do the job.
- "Authority, responsibility, and resources should be placed by each service at the lowest operating management level where all factors of program implementation can be controlled and integrated on a concurrent basis.
- "Administrative channels from the operating management agency to the top policy and approval level must be clear, direct and short.
- "Budget limits should not be arbitrary and in the case of space development, cannot be applied to space as a separate and distinct entity per se."

Gen. Schriever said the critical importance of achieving space weapon capability for national survival requires that every effort be made to compress lead time to a minimum. It is impossible, he added to plan, program, budget and implement on a completely integrated basis the way the military service system is set up at present.

ARPA, he explained, has the development responsibility of all space systems within the Defense Department. It can assign the program to a service to carry out or it can divide it among services. However, ARPA retains project direction and no one service is given the overall management responsibility for the program, nor has the mission responsibility been assigned to date, he testified.

This separates the development element of the overall weapon system from other aspects such as logistics, production, training and operational facilities according to the General.

When the current military space programs were initiated, he said, none of the elements of the total weapon system was in existence. Therefore, to compress time it will be necessary to adopt the essential principles of the management concept of concurrence, wherein each element of the total weapon system is integrated into a single plan, program and budget, and is implemented concurrently, consistent with lead time requirements. It would be costly in time to develop the various subsystems first, he said.

Gen. Schriever said weapon system development based on technical feasibility requires that the military:

- "Conduct a vigorous research, applied research, component and subsystem development program.
- "Conduct constant evaluation and analysis of the programs, aided by science and industry, to insure timely initiation of space weapon system development programs.
- "Centrally manage and control space weapon system programs to insure effective systems engineering, integration and testing, which is essential to the intricate technical interface between and among the several subsystems comprising the total weapon system."

The ability to apply this philosophy of weapon system initiation to space vehicles will be complicated if there is an excessive division of subsystem development projects among agencies or if there is not a timely decision as to the military operator.

Military Role

There is a clear military role firmly attached to space weapon systems now under development, Gen. Schriever said. These systems include the long range ballistic missiles, the reconnaissance and early warning satellites as well as communication, weather, navigation and mapping and charting satellites.

While there isn't any question that space will provide all three services with the ability to do their jobs better, particularly in the support areas, Gen. Schriever added, it will be the Air Force's primary combat mission that will be the most vitally affected.

He said the actual combat role of the Army will not be changed by space because the foot soldier will still be needed to occupy land, and the Navy is going to continue to have ships on the surface and underneath the ocean. However, by 1970 and perhaps long before that, he said, the strategic and air defense missions of the Air Force will be taken over by space weapon systems—ballistic missiles, satellites and spacecraft.

"I think it is clear that our responsibility under the National Security Act is that we provide the systems that will best do the strategic and air defense job," Gen. Schriever emphasized. Unless the Air Force is clearly given this mission to do, we might very well end up being largely an air transport or logistical service."

ARDC Policy Change?

Lt. Gen. Bernard A. Schriever, new commander of USAF's Air Research and Development Command, last week began a two-week tour of the command's nine centers amid strong speculation that he will make extensive changes in ARDC policies and structure.

Although he is expected to write his own program to a great degree, he probably will draw a number of ideas from the still-unimplemented report made almost a year ago by the ad hoc Stever Committee of the USAF Scientific Advisory Board (AW July 14, p. 29 and July 21, p. 23). This report urged a number of changes in USAF research policy and operations procedures, both above and within the command.

Many of the recommended changes were aimed at reversing what the committee called "a growing lack of trust in the capability and performance of individuals at the working level in research and development." Gen. Schriever is expected to move to ARDC headquarters at Andrews AFB, Md., the week of May 25.

Space Weapon Systems

Washington—Major space weapon systems which USAF considers necessary for military space operations of the future, Lt. Gen. Bernard A. Schriever, commander of Air Research and Development Command, told a Senate Space subcommittee, are:

- Offensive weapons—Advanced strategic missile systems and manned strategic space system.
- Defensive weapons—Anti-missile defense system (early warning and extensions), satellite defense system, satellite inspection system and manned defensive space system.
- Reconnaissance systems — Reconnaissance satellite weapon system and infrared subsystem (alert system), visual reconnaissance subsystem and mapping and charting subsystem.
- Supporting systems—Communication satellite, environmental observing and forecasting system, space navigation system, specialized test vehicle, integrated ground acquisition and tracking system and logistic support systems which include recoverable boosters (prime movers), maintenance and resupply and space transportation system.

High Intensity Radiation Produces Convulsions, Death in Monkey

Washington—Recent experiments by National Institute of Health show that close-range exposure of the brain of a monkey to high intensity radio waves can produce convulsions, and five minutes continuous exposure can cause death.

First details on the experiments conducted in March were revealed by Dr. Pearce Bailey, director, National Institute of Neurological Diseases and Blindness, in budget hearings before House Appropriations Subcommittee.

Dr. Bailey speculated that the discovery of possible brain damage from radio/radar waves might explain "mysterious airplane accidents." However, atomic experts point out that a metal fuselage acts as an effective shield and that aircraft operate at considerable distances from powerful radars which further attenuates their energy intensity.

Brain disturbances in the presence of high intensity radiation also have been observed recently in mice, chickens and dogs by scientists at Rome Air Development Center, AVIATION WEEK has learned. RADC tests are part of a program to assess biological damage due to electromagnetic radiation and to establish safe limits for human exposure. It has been known for some time that high internal body temperatures can be produced by exposure at close range to high intensity radar energy, not unlike the controlled effect produced by short-wave diathermy machines for medical use.

In the experiments, the monkey was fastened to a chair in a sitting position inside a drum-shaped cage which served as a resonating cavity to greatly strengthen the electromagnetic energy within the cage. A radio antenna fitted to the top of the cage pointed toward the monkey's head, in line with his brain stem—the central vital portion of the brain. Antenna was excited by an AN/GRC 27 ultra frequency transmitter which operates in the 225 to 400 mc. range, has a peak output of about 100 w.

When the transmitter was turned on, the monkey was apparently unaffected for a few seconds, then it became drowsy. After a minute or so, Dr. Bailey

X-15 Cockpit Mockup Shows Location of Controls

Mockup of the North American X-15 rocket research aircraft was displayed at the Air Force Assn.'s World Congress of Flight in Las Vegas, Nev. The mockup has a wrist control stick on the right hand side (not visible) for conventional aerodynamic control. Center stick moves simultaneously with it. Center stick is installed for landing because pilots are accustomed to using a stick during landing. A semi-wrist motion control is on the left side of the cockpit, it is used for ballistic control and activates small jets for out-of-atmosphere control. This control operates up or down or left or right. Oxidizer and fuel tanks are trimmed with jettison trim control (toggle switch above ballistic control) which trims the center of gravity of the plane and also controls jettisoning of fuel. Sideslip, roll and pitch instrumentation (center of panel) is required for the flight test program to get accurate settings for these regimes, since the conventional ball indicator does not give a close enough reading. This mockup differs somewhat from the actual X-15 cockpit.

NASA Tests Project Mercury Escape System

Escape system of the Project Mercury manned orbital capsule is tested at National Aeronautics and Space Administration Pilotless Research Station, Wallops Island, Va. Escape rockets carried a full-scale one-ton "boilerplate" model of capsule to 2,250-ft. altitude. Tripod then separated and capsule parachuted into water and was recovered by helicopter.

said, the monkey became agitated, moving its head from side to side. In another minute there appeared "unmistakable signs of some impending disturbance in the vital centers of the brain, which were probably resonating with these electromagnetic waves." Dr. Bailey said. Finally the monkey was thrown into a major convulsion a few seconds before death occurred.

Examination of the brains of 10 monkeys which died in the experiments revealed no pathological cause of death, Dr. Bailey said. Another 10 monkeys, whose exposure was cut short of death, showed symptoms which resembled those of Parkinson's disease in humans. Most survivors recovered completely.

Dr. Bailey said the discovery of brain effects offers great possibilities as a new research tool in brain research and ways of developing improved devices to protect against electromagnetic radiation.

Rome Air Development Center tests have been run with radiation intensities of up to one watt per square centimeter on the test animals, approximately 100 times the maximum dosage considered safe for humans. Tests have been conducted over a wide range of frequencies, from approximately 200 mc. to 27,000 mc. All test animal deaths to date have resulted from hyperthermia—excessive internal body temperature.

Although high intensity radiation exposure has produced mental disturbance in the test animals, RADC scientists have succeeded in training some of the animals to perform normal tasks despite the radiation. RADC has an extensive radiation biology program under way at a number of universities, including Buffalo, California, Iowa, Miami, Pennsylvania, Rochester, Tulane and Tufts.

Snecma Arranging For J75 Production

Paris—The state owned engine manufacturer Snecma and Pratt & Whitney are ironing out details of a deal under which Snecma would manufacture J75 jet engines under license (AW Feb. 9, p. 23).

The engines would be used in the production version of the Mirage IV bomber (AW April 27, p. 27) slated to make its first flight in the spring of 1961, and possibly in a Super Caravelle with 90-100 passenger capacity.

The deal involves financial participation by Pratt & Whitney. Although Snecma officials would not disclose what arrangements were being discussed, one indicated that Pratt & Whitney would get some—probably less than 20%—of Snecma's stock now owned by the French government.

Snecma recently signed an agreement with Pratt & Whitney to maintain and overhaul J75s in Europe.

AIA Attacks Renegotiation Board Policy

By Katherine Johnsen

Washington—Aircraft and electronics manufacturers last week called on Congress to prevent the Renegotiation Board from wiping out the incentive profits they earned under contracts with the military services.

William M. Allen, president of Boeing Airplane Co., testifying on behalf of Aircraft Industries Assn., told the House Ways and Means Committee that renegotiation "as currently administered is destroying incentives and depleting the strength of industry so essential to the effective fulfillment of our national defense objectives." The committee is considering extension of the Renegotiation Law, which expires June 30.

Pointing out that Renegotiation Board has repeatedly recaptured from aircraft manufacturers amounts equal to or in excess of their incentive awards from the military services, Allen charged that "the Board has assumed the prerogative of passing judgment on what is the proper profit level for the aircraft industry as a whole."

Awards Nullified

AIA presented these examples to show that Renegotiation Board nullifies incentive awards:

- **Boeing had $25 million** in incentive earnings over three years. The Board ordered a refund of $27 million for the period.
- **Lockheed Aircraft Corp.** earned $12 million in incentive payments for two years, but was ordered by the Board to refund this same amount for the period.
- **North American Aviation** had $23 million in incentive earnings over three years, but was ordered to turn back $29 million for the period by the Board.
- **Douglas Aircraft Co.** had incentive earnings of $2.7 million over two years but was ordered to refund $12 million for this period by the Board.

Three positions as to what the future of renegotiation should be, each with substantial support, were presented at the Ways and Means hearings:

- **Legislation sponsored** by Rep. Cecil King (D. Calif.) which would restrict Renegotiation Board's authority to recapture profits, requires the Board to furnish contractors more extensive information on the basis for its determinations, and give contractors the right to appeal renegotiation determinations from the U. S. Tax Court to the U. S. Court of Appeals, was endorsed by AIA and Electronic Industries Assn.
- **Department of Defense** acquiesced in two changes in the law. These would require the Board, by statute, to give consideration to the incentive pricing provisions of contracts and permit contractors to appeal to the U. S. Court of Appeals.
- **Rep. Carl Vinson** (D. Ga.), chairman of the House Armed Services Committee, denounced all proposed changes and recommended that renegotiation, as is, be made permanent law. The King bill and Defense Department proposed a two-year extension.

Vinson Statement

"For practical purposes," Vinson told the committee, "none of the proposed amendments to the existing law [is] for the benefit of the government. They are only for the benefit of the private contractor. If there were an equity on the side of the contractors in any of these amendments, then I would not oppose them."

Vinson reported that of a total $81.8 million of excess profits determinations by the Renegotiation Board being contested in the Tax Court, seven aircraft companies account for more than $72.1 million. He said these are: Boeing, $26,799,828; Douglas, $8,758,630; Lockheed, $4,254,978; Martin Co., $3,162,759; North American, $17,682,616; Temco Aircraft Corp., $4,844,000; and Grumman Aircraft Engineering Corp., $6,665,000.

Vinson charged that "these are the holders of incentive contracts who would have them specially protected in the legislation proposed by the Department of Defense." Opposing authority to appeal to the Appeals Court, Vinson declared that the recovery of profits ought not to be accomplished by requiring the government to win the cup three times before obtaining permanent possession. "When the Board has made its determination on the question of the fact of excessive profits, and that decision has been formally reviewed by the judges of the Tax Court, any one would be satisfied that there has been substantial evidence to sustain the facts found."

"The Appeals Court could do little more thereafter than frustrate the whole proceedings."

AIA Support

Following are provisions of the King bill supported in AIA's presentation:

- **Profits agreed upon** between the contractor and the military service, plus up to 10% additional in incentive payments, would be exempted from renegotiation. AIA endorsed this "in view of the fact that 'agreed profits' are based upon the minimum amounts which the parties contemplated at the time they entered into the contract and further because we believe that a contractor should be permitted to retain some portion of any additional profits he may be able to earn through efficiency and cost reduction."
- **Board would** be required to consider the stability of defense industry in recapturing profits. "The aircraft in-

Similarity of Profit Percentages

(Compiled by Boeing Airplane Co.)

	Renegotiation Refunds (Before Taxes)	Ratio of Earnings to Sales (Before Federal Income Tax)		Ratio of Earnings to Sales After Renegotiation and After Federal Income Taxes
		Before Reneg.	After Reneg.	
Boeing Airplane Co.				
1952	10,000,000	7.60	6.30	1.9
1953	7,500,000	7.06	6.30	1.9
1954	10,000,000	7.20	6.31	3.0
North American Aviation, Inc.				
1953	6,000,000	7.39	6.46	2.1
1954	14,000,000	8.59	6.56	2.9
1955	9,000,000	7.70	6.63	3.2
Lockheed Aircraft Co.				
1953	6,000,000	6.90	6.17	1.9
1954	6,000,000	7.17	6.30	3.0
Douglas Aircraft Co.				
1953	6,000,000	6.39	5.65	1.7
1954	6,000,000	6.39	5.64	2.6

dustry as a whole, as well as a given company within that industry, is perhaps more susceptible to fluctuations in business than any other," AIA commented "All we ask is that the Board give consideration to this factor"

• **Board would have to give** contractors the evidence it considered in arriving at a determination of excess profits "At present the Board refuses to make known to the contractor the evidentiary basis, or lack thereof," AIA declared "It would seem to be nothing more than elemental fairness to require the Board to make a full disclosure of the facts..."

• **Board would** have to give Congress annually a detailed report on each proceeding involving more than $20 million of renegotiable business AIA said this would furnish contractors "with a source of much needed information" which they could use in their own renegotiation proceedings

• **Tax Court would be directed** not to assume that the Board's determination is correct in its review, leaving the burden of proof to the contractor "The Tax Court appears to proceed on the assumption that the Board's determination of excessive profits is correct and has several times sustained such a determination on the ground that the contractor has failed to prove it wrong," AIA said

Burden of Proof

Renegotiation Board pointed out to the committee that the burden of proof is placed on the contractor by regulations of the Tax Court Thomas Coggeshall, Board chairman, commented that "this is the traditional principle of Anglo-Saxon jurisprudence that the burden of proof rests upon the moving or petitioning party The petitioner in a renegotiation case in the Tax Court is the contractor."

Coggeshall challenged the profit formula of the King bill—"agreed profit" plus 10% additional—"specifically, on the basis of actual experience, would have the effect of exempting all, or virtually all, the large profits realized by the members of the airframe industry..."

In addition, he objected "it would delegate to contracting officers all over the country the power to decide the extent to which profits shall be exempt from renegotiation"

In the case of subcontracts, he declared the situation would be "infinitely worse," since the "agreed profit" would be arrived at by two private individuals—contractor and subcontractor "This would amount to a capricious and wholly unsupportable delegation to private individuals of the authority of the Congress to exempt profits from renegotiation."

Defense Department Opposes Bill Calling for Single System Manager

Washington—Department of Defense is opposed to widespread use of a single weapon system prime contractor in military procurement

This is a key feature of comprehensive procurement legislation, sponsored by Sen Leverett Saltonstall (R, Mass), aimed at cutting lead time on advanced weapons production by decentralizing authority and responsibility and cutting red tape (AW Aug 18, p 26) The measure provides for a single "system manager," designated by the secretary of the service letting the contract, and a single prime contractor—unless there is good reason for an alternative type of procurement

In a report on the Saltonstall legislation to the Senate Armed Services Committee, Robert Dechert, Department of Defense general counsel, said, in effect, that the department should have a free hand to select whatever type of procurement it might consider suitable.

"No single method of formula provides an answer to the management or procurement of weapon systems," Dechert stated "The nature of the item, the state of the art, the 'in-house' or contractor capability, the degree or urgency, differ from weapon system to weapon system . . . To emphasize a single weapon system manager on one hand, and a single prime contractor, without recognizing capability within the government itself, or of other contractors is unduly restrictive In this period of evolution, flexibility of approach is essential"

He pointed out that, particularly in the missile field, the department prefers several prime contractors—one for assembly and one for each major subsystem—with "no one contractor, in reality, a weapon system contractor"

Major Contractors

Meanwhile, two major defense contractors endorsed the Saltonstall provision for encouragement of single manager and single prime contractor, in testimony before the Senate Small Business Committee

• **Frank L Dobbins,** director of material of Boeing Airplane Co "The concentration of management responsibility, both within the procuring agency and within industry, which is the significant feature of this method of procurement, can, we believe, significantly expedite the development and delivery of advanced weapons of increased quality at a reduction in cost

• **C W La Pierre,** vice president of General Electric Co "I am definitely in favor of procuring complete defense systems from a single prime contractor who will have over-all responsibility for the design, development, and production of the system In saying this, it should be known that General Electric is more often a supplier of major components than we are a prime contractor of systems"

These are the positions taken on other provisions of the Saltonstall bill

• **Elevation** of "competitive negotiation" to equal status with advertised procurement At present, negotiation can be used only when advertised bidding is impossible This change was urged by the Department of Defense, as well as the two industry spokesmen "There is a serious misconception in the public mind that competition is obtained only under formal advertising," Dechert commented

• **Use of "performance specifications"** instead of the elaborate detailed specifications now required in contracts La Pierre declared that "broad performance specifications is the only effective way of purchasing the highly technical modern defense equipment" Dechert and Dobbins recommended that the type of specifications be left optional to suit the type of procurement "There are many occasions when the use of design specifications or a combination of both design and performance specifications will best serve the interests of the government," Dechert commented Dobbins cautioned that there are cases "where a performance specification would be far more complex than a description of the physical details of the item"

• **Provide** "set-asides," exclusively for subcontracting with small business, in prime contracts Dechert pointed out that it might be "an administrative burden to designate particular items for set-asides . . . and delay performance" Dobbins said that "competitive bids should be secured from both large and small business in order to ensure that we obtain the best quality and the best price available" La Pierre commented that "these tremendous systems are not easy to build, and any dictation of how it is to be done and who is going to be used, will detract from the flexibility that a fast-moving technology requires"

• **Exempt fixed price,** formally advertised and incentive-type contracts from renegotiation law (see p 31) Dobbins said that this "represents one constructive approach to one important aspect of the renegotiation problem"

Hound Dog Undergoes Operational Testing

Two USAF North American Aviation GAM-77 Hound Dog air-to-ground missiles are mounted on pylons beneath wings of a Boeing B-52 Strategic Air Command bomber Hound Dog, in operational test phase, is powered by Pratt & Whitney J52 (7,500 lb thrust).

Space Technology

Soviets Plan Surveillance Satellite Launch

Washington—Russia plans to pursue three major space exploration programs simultaneously "in the nearest future," according to an article by Prof G V Petrovich in an official publication of the USSR Academy of Sciences

The three concurrent programs which are projected for years ahead concern

• **Earth satellites** of varying weights and purposes The first satellites of the new program will be designed to keep the entire earth and space near the earth under constant observation and they will be launched into approximately polar orbits Prof Petrovich has stated that the instrumentation will include such devices as optical and television apparatuses

• **Recovery** of the satellites or their essential parts with and without the use of wings, is an objective of the program First instruments, then animals and finally men will return to earth from space in such vehicles according to Soviet plans Once this has been accomplished the Russians plan "full fledged, well equipped" satellites and a space station for more detailed observation of the earth and space and later to act as servicing stations for interplanetary vehicles Planned altitudes of the satellites vary from a few hundred miles for the first units designed for earth observation to tens of thousands of miles for the space stations

• **Moon exploration** First vehicle in this program was "Mechta" launched last Jan 2 which Prof Petrovich claims came within 3,107 to 3,728 mi of the moon Subsequent flights will circle the moon, photograph the back side and transmit the picture to earth Some of the later exploration rockets will be placed into orbit around the moon These and others which are satellites of the earth will be used to map space within 300,000 mi of the earth Soviets plan to place scientific instruments on the moon before manned flights are attempted Prof Petrovich said that landing of men for a direct study of that body is a "logical and unavoidable event" First manned lunar flights would only circle the moon and return to earth The Russians believe that they will be able to land instruments and men on the moon virtually without impact and in precise locations, using retrorockets To relieve the strenuous design problems for multi-stage manned rockets, powered by presently known chemical engines, which can take off from the earth land on the moon and return to earth, the Russians plan to store fuel on the moon before men land there Fuel containers would be dropped from unmanned rockets The stored fuel would allow a lighter moon landing vehicle to be used and would be necessary for the return trip to earth The Soviets would increase the probability of a successful trip to the moon by sending two rockets together so that the crews could return to the earth together in the event that one of the vehicles experienced a catastrophic failure.

• **Interplanetary exploration** Preparation for unmanned reconnaissance rockets to Venus and Mars is considered feasible now by the Soviets and they intend to come as close to the target planet as possible These first flights will travel along a minimum energy trajectory so that a maximum load of scientific equipment can be carried

First Quarter Reports Emphasize Intense Search for New Business

Sales and profits were off for Chance Vought Aircraft, Inc., in the first quarter this year, but company officials told stockholders at the annual meeting that 1959 is still expected to be the company's second best year.

The company has mounted a substantial sales effort to get new business to replace the canceled Regulus II and F8U-3 programs. Award of the Project Scout airframe contract was one result of this continuing effort.

Sales in the first quarter totaled $66,295,732 and net profit was $1,506,023. This marks a decline from sales of $78,401,110 and net income of $2,312,451 for the same period last year. Earnings amounted to $1.27 a share in the 1959 quarter compared with $2.12 on approximately 10% fewer shares in the first quarter last year.

Working capital at the end of the three-month period was $39.9 million. Credit line arranged for the year ending Mar. 31, 1960, is $30 million.

The Project Scout contract represents Chance Vought's first hardware commitment in the astronautics field, an area the company regards as one of its future major interests. The contract also brings the company a new customer, National Aeronautics and Space Administration, and if the Air Force makes substantial use of the Scout vehicle, it will represent Chance Vought's first major USAF business. In addition to the Scout contract, Vice President-General Manager R. C. Blaylock told stockholders that Chance Vought has five major proposals pending and that the company intends to go after the world-wide tracking facilities project for Project Mercury, teaming with "a strong partner."

Other financial reports:

• **Bell Aircraft Corp.** reported first quarter sales declined 39% compared with the 1958 period. Earnings were $690,721 or 26 cents a share on sales of $29,093,532. The earnings figure was an 11.6% decline from last year's first quarter.

• **Republic Aviation Corp.** sales rose from $35,831,275 in the first 1958 quarter to $53,105,700 this year, but earnings for the same period dropped from $702,209 or 48 cents a share to $581,940 or 40 cents a share.

• **Martin Co.'s** first quarter earnings were $3,038,470 or $1.04 a share on sales of $122,159,105. This was a sharp increase over first quarter figures for 1958—earnings of $1,693,000 or 58 cents a share on sales of $96,361,490—but was in line with figures for the latter part of last year.

• **American Bosch Arma** first quarter sales rose to $31,177,327 compared with $27,018,890 for the same period a year ago. Earnings rose 62%—from $886,708 or 46 cents a share to $1,444,995 or 76 cents a share. Defense backlog was $196 million.

• **McDonnell Aircraft Corp.** in the nine months ended Mar. 31 earned $7,070,644, or a margin of 2.1% on sales of $328,690,254. Earnings were equal to $4.27 a share. Comparable figures last year were earnings of $6,681,200 or $4.06 a share on sales of $321,993,672, also a 2.1% profit margin.

• **Temco Aircraft Corp.** reported higher sales but slimmer profit margins for the first quarter as the company moved to decentralize and prepare for expansion into new markets.

Temco President Robert McCulloch told the annual stockholders meeting that the company is in a period of transition from complete dependence on airframe subcontracting to emphasis on such areas as electronics and missile work, and that current sales and profits are symptoms of this transition. He said sales this year may dip as much as 8% below the 1958 level.

Sales in the first quarter were $29,142,563, a slight increase from the $27,157,059 figure for the same period last year. Profits were $589,642 last year and $467,156 this year in the first quarter. Backlog on Mar. 31, 1959, was $85.6 million, and McCulloch said Temco is currently entered in competitions with a total dollar value of more than $500 million.

Decentralizing to provide for a shift to new markets, Temco has split its operations up among three new divisions. An Electronics Division has been established under A. R. Teasdale for development and manufacture of systems and components produced by the company's growing electronics capability. A Missiles and Aircraft Division, headed by R. E. Galer, will handle such programs as the Corvus missile system and the TT-1 trainer, as well as subcontracting work. The new Aircraft Overhaul and Modification Division, led by E. Fred Buehring, covers overhaul and modification work on such aircraft as the C-97, KC-97 and C-121C.

Navy Satellite Group

Washington—Navy has formed two committees to study naval implications of earth satellites. One group consisted of civilian scientists, serves under the Operations Analysis Division of the Office of Naval Research. The other, composed of Navy officers, functions under the Chief of Naval Operation's office.

Latter group last week was briefed on projected programs by representatives of 14 industry groups. The Office of Naval Research group is scheduled to brief the officer's committee this week on scientists's ideas of the potential of earth satellites for the Navy.

Nuclear Ramjet Budget Boosted

Washington—Contract extension in March by Air Research and Development Command's Wright Air Development Center has boosted budget levels for nuclear ramjet development on Project Pluto at Marquardt Aircraft Co. Marquardt's staff on the joint Air Force-Atomic Energy Commission project has increased from about 40 in January to the present level of about 110.

About half of the company's Pluto effort is in support of feasibility tests on non-flyable reactors scheduled to be conducted by University of California's Lawrence Radiation Laboratory for AEC in Nevada Test Site's Jackass Flats area. In the test program for the initial test reactor, known as Tory II, Marquardt is designing and fabricating major portions of the reactor control system, the air ducts, flow instrumentation and remotely operated disconnects. It will also build and test structural components of the reactor core, will supply architect-engineering services on the test air supply system, and participate in a supporting program of environmental tests.

The remainder of Marquardt's effort on Pluto is concerned with design and development of its MA50 nuclear ramjet, for which the company also is designing the reactor, based on the principles of the non-flyable Tory II reactor. Major effort is on airborne reactor controls to meet severe environmental specifications, particularly temperature and radiation. As part of this program, the company has conducted in-pile tests of control components at Convair's Ft. Worth reactor facility.

Marquardt also has collaborated with industry members on studies (AW April 6, p. 37) of possible applications embodying the MA50 nuclear ramjet. Considerable Marquardt effort has gone into preliminary design of test facilities for full-scale powerplant development.

North American Aviation's Atomics International Division is performing materials research in support of the Lawrence Radiation Laboratory program.

NASA Awards Delta Contract to Douglas

Washington—Contract for $24,067,500 for 12 Delta satellite and space vehicles was awarded to Douglas Aircraft Co., Inc., last week by National Aeronautics and Space Administration. Delta will be used as an interim space vehicle in 1960 and 1961.

Delta is a three-stage Thor-Able of the type used last year by Air Force as lunar probes, but with a Bell Telephone Laboratories radio inertial guidance system and coasting guidance control added. Two-stage version of Thor-Able equipped with the Bell Telephone guidance, has been fired five times over the Atlantic Missile Range as a nose cone and guidance test vehicle. Two of the five shots have been considered successful and three partially successful.

Missions planned for Delta include launching of equatorial and polar satellites and deep space probes. NASA also has told Congress that Delta could deliver a 100 lb. payload for a lunar impact, 65 lb. payload for an orbit around the moon, and 50 lb. for a rough lunar landing. (AW April 13, p. 28) Delta is expected to cost about $2.5 million per vehicle after development. (AW April 13, p. 129)

Delta is expected to be able to put 250 lb. in a 300-mi. earth orbit or send a 100 lb. payload deep into space. Stages are the Douglas Thor, powered by a Rocketdyne liquid propellant engine, an Aerojet-General Corp. Vanguard engine with guidance incorporated in this stage. Allegany Ballistics Laboratory solid propellant stage, also developed in the Vanguard program, and payload. Guidance will allow more precise control during the early part of the flight and active guidance control of longer coasting periods between second stage burnout and third stage ignition. Added coasting time results in maximum velocity being obtained at higher altitudes.

NASA Names Center After R. H. Goddard

Washington—New space research and development center for National Aeronautics and Space Administration will be named the Goddard Space Flight Center in memory of U. S. rocket pioneer Robert H. Goddard.

The center will consist initially of space projects building and a research projects laboratory to be located on a 55-acre tract acquired from the government's Beltsville Agricultural Center, northeast of Washington. Post Office address will be Greenbelt, Md. Completion of the buildings is scheduled sometime in mid-1960. Missions will include basic research and development. Eventually the center will become a command control center for space flight operations.

Abe Silverstein, NASA's director of space flight development, will give overall guidance to the center from NASA headquarters. Center director has not yet been named. The center will house three major research and development groups headed by assistant directors and departments of business administration and technical services.

Assistant directors are John W. Townsend, Jr., for space science and satellite applications, John T. Mengel for tracking and data systems, Robert R. Gilruth for manned satellites. Michael J. Vaccaro will be business manager.

In another move, NASA has named John P. Hagen, former chief of its Vanguard Division, as assistant NASA director for program coordination, and has integrated the Vanguard group into other major space flight projects.

Executives Promoted In Three Companies

New York—Promotions of top executives in three widely diversified companies were announced last week.

At General Dynamics Corp., Frank Pace, Jr., was elected chairman of the board and chief executive officer, with Earl D. Johnson, vice president, moving into Pace's post as president.

William B. Bergen, executive vice president of The Martin Co. was elected president, directing the functions of seven operating divisions. George M. Bunker, board chairman and chief executive officer, remains in that post.

General Precision Equipment Corp. directors elected James W. Murray, president of General Precision Laboratory, Inc., as board chairman and D. W. Smith, president of Kearfott Co., Inc., as president. Murray succeeds H. C. Place, who was elected founder chairman, and Smith takes over from E. A. Link, former president, who retired from that office. Link, however, will continue as director of avionics programs and will remain on the board.

Other General Dynamics appointments include:

- **Carleton Slingg,** president of the Electric Boat Division. A senior vice president, he was the division's general manager at Croton, Conn.
- **Dr. Frederic E. Hoffmann,** president of the General Atomic Division, from his post as the division's general manager. He also becomes a senior vice president.
- **C. Rhoades MacBride,** senior vice president-operations. He formerly was vice president-operations.

Discoverer Passengers

Boston—Four white mice in a return capsule will be launched with Discoverer III into a polar orbit in about a month, Rep. Overton Brooks (D-La.), chairman of the House Committee on Science and Astronautics disclosed here last week at the American Rocket Society conference on controllable satellites.

The 2-ft. long, 35-lb. capsule housing the four mice will be ejected over the Pacific Ocean. Recovery will be attempted by aircraft equipped with an snatch probes. Existence of a new (third) radiation belt consisting of very "soft" nonhazardous protons surrounding the earth at an altitude of 20,000 to 30,000 mi. was predicted by Dr. Fred Singer of the University of Maryland.

News Digest

Army Ballistic Laboratory at Aberdeen Proving Ground, Md., is developing a solid propellant that Army says will be 10 to 15% more efficient than existing fuels. Ingredients are nitrocellulose, nitroglycerine, polyurethane, ammonium perchlorate, aluminum, magnesium oxide and two-nitro diphenylamine.

Decca Navigator Co., Ltd. has issued a statement calling the February special meeting of International Civil Aviation Organization in Montreal a "complete farce." Company charges that the meeting did not decide the issue of VOR/DME-T is Decca on technical grounds.

Lockheed Aircraft Corp. will build a supported monorail system for the Seattle Century 21 Exposition Corp. under $5 million contract.

Eastern Airlines last week gained Federal Aviation Administration authorization to raise the overhaul time on its Allison 501D engine in its Lockheed Electras to 1,000 hr.

Hughes Aircraft Co. will soon obtain two Convair B-58 Hustler jet bombers as testbeds for the fire control system of North American's F-108 long range Mach 3 interceptor. In addition, International Business Machine Corp. will receive a B-58 for use in development of its bomb-navigation system for the North American B-70.

Aeronca Manufacturing Corp. will produce the Pogo-Hi II E3C target missile system for White Sands Missile Range, N. M., under a $328,000 Army Ordnance Missile Command contract.

U.S. Airlines Accumulate Jet Experience

Turbojet transports require precise handling in air and on ground; ingestion so far is no great problem.

By Glenn Garrison

New York—Teething troubles of the first U.S. jet services have been mostly of a minor nature, and so far the jets are fitting fairly smoothly into the pattern of airline operations.

The U.S. jet age began six months ago at New York International Airport when Pan American World Airways inaugurated service to Paris with its Boeing 707-120 jet transports. Now five airlines operate a total of 22 jet schedules a day in and out of Idlewild, and the volume will increase this summer.

Load factors have been extremely high and preliminary cost figures are promising. The big question is how greatly some of the problems will be magnified when jet traffic volumes increase and what the competitive buildup will do to loads.

Based on the initial experience:

- **The jet is a "handle with care" airplane,** requiring precise pilot techniques on the ground and in the air. Pilots are taking longer than had been expected to check out in the 707-120.
- **Engine ingestion** of foreign material, a major worry before the start of services, has so far proved much less of a problem than had been expected. One engine removal was first attributed to this cause, but that finding was later reversed (AW Dec. 22, p. 37).
- **Air traffic control** has not proved a serious problem for jets at terminals, but military blocking of en route air space and traffic control altitude changes have caused delays.
- **Contrary to previous planning,** the 707-120 with Pratt & Whitney JT3 engines will be operated transcontinentally at high speed rather than reduced power cruise. Recent studies indicate that, competitive speed racing aside, it may prove more economical.
- **Turbojet powerplants** have given very little trouble, less than those of their piston predecessors. Most bugs have been confined to aircraft systems and accessories such as the water injection pump.
- **Community reaction** from the noise of jets has not been bad, but anti-noise operating procedures at Idlewild are most unpopular with the airlines.
- **Safe and efficient operation of jets** may require new airport and navigation aids, such as runway barrier fences and improved approach instrumentation. Ramp handling of jets has been fairly satisfactory, although engine blast proved to be more of a problem than anticipated and has caused a change in Idlewild ground procedures. Ticketing and loading and unloading the bigger passenger volumes have not created serious problems so far.
- **Jet schedules** have encountered many delays, but few cancellations.

Idlewild, the present hub of jet operations, is undergoing changes which will make life easier for jet operators by the time the volumes grow. Four U.S. carriers—American Airlines, Eastern Air Lines, Pan American and United Air Lines, will complete construction this year of their multi-million-dollar individual passenger terminals in the airport's $150 million "terminal city" development.

Trans World Airlines and Northwest Orient Airlines will follow suit later. As these terminals are completed, the airlines can move their jet operations away from the inadequate temporary terminal now in use, and can set up their own ramp handling procedures.

Engine blast emerged as a major problem during the early period of operation from the old terminal. In several instances, heavy equipment such as passenger stairs was blown across the ramp by blast and the Port of New York Authority, operator of the airport, ruled that blast fences must be installed at the jet gates.

These concrete fences proved unsatisfactory and the Port Authority added a requirement that turbojet transports be towed away from the gates before taxi power was applied. This ended at least temporarily the experiment with taxiing in and out from the gates, and the tow out adds time and trouble.

The Port Authority in other ways has found turbojet transports, from an airport operator's standpoint, less of a problem than had been feared. For example, deterioration of pavement from jet heat and fuel spill has not materialized to date. There have been no passenger complaints regarding noise at the ramp. Taxiway and jet runway sweeping has been handled satisfactorily, first by airport personnel cruising in a tractor and watching out for foreign objects, and since January using a Consolidated Diesel Electric Corp. motorized vacuum sweeper.

Ninety per cent of the Idlewild sweepings have consisted of clam shells dropped by seagulls. Because of this, Pratt & Whitney is now running tests to determine what effect clam shells have on its engines.

Runway 25 at Idlewild, the top priority jet runway because it takes the aircraft out over water, is being resurfaced at present. Roughness of this runway caused problems with high speed jet takeoffs.

Here is a report on the experience of each airline operating jets at U.S. airports in the order of their entry:

- **British Overseas Airways Corp.** has achieved an average passenger load factor of 80.90% on its de Havilland Comet 4 jets from the beginning of transatlantic service Oct. 4. It now operates a daily round trip from New York and a weekly flight from Montreal. BOAC says engineering delays amount to less than 20% of time lost in schedule delays, with weather being the principal factor in delays. About 30% of 309 Comet flights arrived on time, 71% arrived on time or within an hour of schedule, and 95% on time or within six hours.
- **Pan American** has carried almost 65,000 passengers since inaugurating the first U.S. airline jet service with the U.S. commercial jet airplane last Oct. 26. Load factor has averaged 91%. Pan American of course, encountered the drawbacks as well as the rewards of being first with the new airplane. It has had three incidents resulting in planes being out of service for major mechanical work, a dive to 6,000 ft. on a scheduled transatlantic flight, cause of which has not been officially determined, separation of an engine pod during a training maneuver over France, and a takeoff undershoot on a check flight involving loss of a landing gear and engine pod damage. Pan American has found the 707-120 engine a good one, especially compared with the powerplant of its latest-model piston plane. The J57, however, has not been trouble free by any means in Pan American's experience. Problems have included third-stage turbine wheel bearing troubles, erosion of seal rings, some trouble with turbines and guide vanes. On the other hand, expected trouble with hot section components such as burner cans and nozzles has not materialized. The three worst bugs in the aircraft systems, from Pan American's standpoint, have been the entire water injection system, the fuel gages, and the autothrottle. There have been others, including freezing and cracking of airplane water system parts.

Blade Damage

There has been occasional blade damage from ingestion but of such minor nature that the blades were removed only at inspection intervals. Operationally, the Port of New York Authority restrictions probably have hurt Pan American more than any other carrier. Runway 25, first priority jet runway, was 8,200 ft. when PanAm began service, greatly reducing eastbound nonstop potential. The New York-London record for last November was 25% nonstop. Runway 25 was lengthened to 10,000 ft., and the December record went to 68%. January was 100%, February 100%, and March 92%. On the Paris run, nonstop performance was hampered by big mail and cargo loads. The record to Paris November, 7%; December, 29%; January, 81%; February, 71%; March, 74%. With hot weather this summer, depending on payload policy, Paris nonstops could drop to 40-50% and London nonstops to 80%.

- **National Airlines** has averaged 92% in load factor on almost 600 scheduled flights since Dec. 10 with leased PanAm 707-120s. This compares, the airline says, with a 50-60% load factor on its piston equipment over the same New York-Miami route. Passengers carried on the jets have totaled about 54,500. Operating cost studies show the 707-120 to be 7 to 10% less expensive to operate than the Douglas DC-7B, according to National. The airline has suffered numerous delays usually caused by receiving its jets late from Pan American, it says. Traffic delays at takeoff also have been a factor. The only schedule cancellations have been because of weather. There have been three flight diversions, two from weather and one because of a malfunctioning fuel control. Pilot transition has run from 17 to 37 hr. higher than expected. All in all, training five crews cost National $304,500. National is little affected by the Idlewild noise rules, since the 707-120s takeoff gross for the run is only 205,000 lb.
- **American Airlines** flew its 50,000th jet passenger last week, achieving an average load factor over 95% to date since its first jet flight Jan. 25. Its Boeing 707-120s now fly New York-Los Angeles, Chicago-Los Angeles and New York-Chicago-San Francisco, a total of five round trips daily. Introduction of jets has been different from introduction of past equipment in that "the big things have been done so well, it's the little things that have been our problems," according to Marvin Whitlock, vice president-operations planning. For example, American's experience with its jet engines has been almost trouble free, whereas one of the biggest headaches and cause of delays has been fuel gage trouble caused by a wiring difficulty. Parts have been a problem, partly because the airline provisioned "rather than to start with. This has exaggerated delays that would have been only 30-40 min. to seven to eight hours while parts were flown from one station to another.

At the worst point as far as delays are concerned, about half of American's jet flights were suffering delays from all causes. The rate is now running about one or two delays a day, mostly because of the fuel gage problem, which is still being studied.

American expects to start pulling its first engines for overhaul in a few weeks. Time is now 800, expected to reach 1,000 hr. around fall. Whitlock told AVIATION WEEK that runway barriers will be "mandatory," not so much for overshoot landings as for aborted takeoffs. He also would like to see development of radio altimetry, not so much for en route information as for approach use. Airports handling jets also need back course ILS and/or at least the altitude portion of Precision Approach Radar, in Whitlock's view. American now makes no back course approaches at Idlewild, and circles to use the instrumented end. One fact American has learned from its experience is that a jet can't be comfortably taken off from a slushy runway. American also has found a need for much more airplane time for pilot training than had been anticipated.

- **TWA** came into the jet picture Mar. 20 with daily New York-San Francisco service, now also flies its 707-120s on daily round trips between New York and Los Angeles and one between Chicago and Los Angeles. Last week the airline completed 29 million jet passenger miles with load factors averaging over 96%. It has completed 98.8% of scheduled mileage. There have been only two delays over 10 min. for mechanical reasons, one a water pump and the other a main gear snubber. Air traffic delays have been minor. TWA operated its service from inauguration until April 9 with one line airplane, meeting all schedules. Payload has not been restricted by Idlewild rules but may when summer weather arrives. The airline has experienced one premature engine removal. The engine had been removed for third stage turbine inspection when metal chips were found in the oil. Pratt & Whitney overhauled the engine under warranty. This was not an ingestion incident, and TWA also is optimistic about the ingestion situation. There have been two diversions, both due to weather. Pilot training has taken longer than expected; the target of 12 hr. now stands at 20 hr. Few maintenance problems have been encountered, "nothing more than ordinary." These have been mostly in systems; water pump failures and integrated flight system troubles are examples. TWA expected its sixth jet last week.

National's Jet Costs

National Airlines' net operating revenue for its leased Boeing 707-120 jet operation from Dec. 10 through January was $672,955, according to the airline's figures. Total operating revenue for the period was $1,642,473 and expenses were $969,518.

Flying operations for the jet cost 254.87 cents per revenue mile by National's figures, which include the cost of leasing the equipment from Pan American.

National figures its breakeven passenger load factor for the period at 57.47%. Total revenue breakeven load factor was 48.73%. Revenue miles flown were 212,850, revenue passenger miles 20,777, available miles 23,431, load factor 88.67, yield 7.20 cents.

Cost of training, not reflected in the above figures, was put at $304,534.

PanAm Jet Costs

New York—Preliminary Pan American cost figures for its Boeing 707-120 jet operations are close to anticipated results. Costs of flying operations, direct maintenance and depreciation (including certain main component parts) are reported at 202.5 cents per total mile. Breakdown is flying operations 106.3 cents; direct maintenance, 43.5 cents, depreciation, 52.7 cents. These figures include a number of accruals for as yet unfirm elements, and may be adjusted in later quarterly figures.

By the flight hour PanAm figures its direct maintenance 707-120 costs at about $214. This compares with approximate figures for the Douglas DC-4 of $30, the DC-6 at $40, the DC-7 at $70, and the Boeing Stratocruiser at $100. The preliminary 707-120 figure includes allowances for learning curves and debugging. The airline estimates it may be able to bring the $214 figure down below $200 within the next year, partly because it will soon be doing its own engine overhaul.

Piston Fleet Phaseout Will Cut Capacity Over Atlantic

New York—A sharp dip in the curve of transatlantic airline capacity is in prospect for this year as most carriers, their last piston fleet units already in service, wait to enter the jet competition on the route.

The total of scheduled seats available on the North Atlantic, which rose a record 33% in 1958 over the previous year, probably will go up only about 10% in 1959, an AVIATION WEEK survey shows. At the same time low-fare charter traffic, up 95% last year over 1957, is likely to increase again. By increasing their efforts in the charter market and holding down their scheduled offerings, many carriers are making sure their piston aircraft seats are filled even if they bring in less revenue at the lower rates.

During what is an interim year on the transatlantic run for most carriers, scheduled traffic is expected to increase about 18% over last year's total of 1,193,000 passengers. During the first three months of 1959, this traffic was up 19% to 189,600 passengers. Seats available total was up 14% to 341,300 seats.

By way of comparison, the first quarter 1958 seats available total was up 23% from first quarter 1957 and traffic was up 5%.

With the introduction of the economy fare last April, most transatlantic carriers geared their summer peak schedules for a vast expansion of business. This year's traffic increase of 23% over 1957 met their expectations to some degree, but they had achieved the same percentage increase in 1957 with only 18% more seats instead of 33%. There were 732,000 empty seats during 1958, only 428,000 the year before.

Traffic Pattern

While there are some important exceptions, the pattern appears to be to hold the line this summer in seat offerings or even in some cases to cut back. Examples:

• **Pan American World Airways**, although it is one of the only two jet operators this year on the Atlantic and is well out in front in jet capacity, will offer fewer peak season seats this year than in 1958. Pan American scheduled 84 flights in each direction last year during a peak week in June, this year's comparable offering will be 50 flights, a frequency reduction of 34. However, half the 1959 peak flights will be Boeing 707-120 jet schedules which will account for some 75% of the total capacity. Not allowing for extra sections, the June peak weekly seats may total about 500 less in each direction this year than last. For the entire peak season June through September, Pan American plans this year to schedule 81,762 seats in each direction, of which 56,838 will be economy class and 24,924 will be first and de luxe. The airline estimates its 1959 traffic increase at 8-10% in the first class category and 15-20% in economy business.

• **Trans World Airlines** will offer about 41% fewer scheduled seats during an average peak week this year, or a total of 5,550 in both directions. The split will be 920 first class, 4,430 economy. But TWA also will be carrying 90,900 Military Air Transport Service charter passengers across the Atlantic this year under a contract which also involved 23,964 MATS passengers during the last quarter of 1958.

• **Scandinavian Airlines System** will schedule three fewer flights out of New York during this peak season, and expects a capacity reduction of 5.8%. Its West Coast Europe polar route schedules will remain the same, with slightly heavier emphasis on economy class. The New York-Europe seats will split 82% economy, 18% first.

• **KLM Royal Dutch Airlines** will raise its transatlantic scheduled capacity between the U. S. and Europe 8.4% this season. The carrier's scheduled capacity for the whole of 1958 was about 37% greater than in 1957. The 1959 peak weekly total will be 2,589 seats, split economy 2,185, first and de luxe 404. KLM predicts a 1959 traffic increase of 20%.

BOAC's Plans

On the other side of the 1959 coin, British Overseas Airways Corp., the other jet airline this year, plans to offer 32% more peak seats on the Atlantic. Of the 3,301-seat eastbound peak week total this year, 11% will be offered in BOAC's de Havilland Comet 4 jets. Forty-three eastbound flights will be scheduled, compared with 39 last year during a peak week. Bookings ahead on the list last month showed a 22.6% increase over the total at the same 1958 time.

BOAC also is operating its turboprop Bristol Britannias on the route again this year, in first-tourist-economy or de luxe-tourist-economy configurations. Its Douglas DC-7C piston flights will all be mixed tourist and economy. Comets will be used in all-first-class (including de luxe) configuration. BOAC says its transatlantic passenger traffic increased 54% in first quarter 1959 over first quarter 1958.

With BOAC geared to exploit its turbine aircraft to the full, the only other transatlantic carrier among the big six of traffic volume to increase its capacity greatly is Air France. The French carrier will boost its seats available by 18% for a peak week eastbound total of 2,106, of which 1,755 will be economy. However, last year's total capacity was 34% over 1957's.

Among the above six airlines only SAS went the whole way and eliminated the tourist class when the economy fare came in last April. This summer, however, only BOAC among the six will offer tourist seats.

Other Carriers

Among the relatively smaller transatlantic carriers, Alitalia is an outstanding exception to the capacity trend with plans for an increase of about 73%. It predicts a 100% increase over the 26,429 passengers carried last year.

Sabena Belgian World Airlines offered 14,534 seats during an eight-week period in June and July last year, the comparable total will drop to 12,494 this year. Swissair's weekly total of 12 transatlantic round trips last summer will remain the same this year, but the airline expects a 20% increase in traffic.

The 33% increase in capacity last year was abetted by the introduction of new fleets of larger aircraft and by the economy class configurations. After the tourist class was introduced in May, 1952, total capacity that year went up 24% and the traffic jump was 31%. Another 25% capacity increase in 1953, however, brought a traffic rise of only 17%, as can be seen in the following table:

Year	Seats	% of Gain
1951	504,185	2%
1952	625,758	24%
1953	781,737	25%
1954	880,938	13%
1955	1,006,000	14%
1956	1,226,861	22%
1957	1,450,000	18%
1958	1,925,000	33%
Year	**Passengers**	**% of Gain**
1951	329,656	6%
1952	432,272	31%
1953	506,601	17%
1954	550,000	8%
1955	652,000	18%
1956	785,259	20%
1957	968,151	23%
1958	1,193,000	23%

In addition to the 1,193,000 scheduled passengers carried last year over the North Atlantic, almost another 100,000 passengers flew in chartered aircraft of the scheduled lines. This total was an increase of some 95% over the year before, and came in the same year that the new and highly touted economy fare was available.

During 1959, according to AVIATION WEEK's survey, the scheduled airlines may increase their charter traffic to a total somewhere around 150,000 passengers. Among the examples that point up this trend:

• **Air France** flew 31 transatlantic charters last year, carrying 2,339 passengers. This year the airline expects to handle at least 52 charters.

• **Trans World Airlines** carried 20,911 charter passengers on the route last year in addition to the MATS traffic noted above. Because of the heavy MATS commitment, TWA's charter business will be somewhat less this year, but it is still expected to total some 18,000 passengers.

• **Pan American** carried 23,378 charter passengers last year, and expects a 1959 increase of up to 10%.

• **Lufthansa German Airlines** flew eight charters last year, expects about 25 this year.

• **SAS** carried 1,445 charter passengers in 1958, and expects more than double that volume this year. BOAC looks for a 150% increase. Swissair expects a 50% rise.

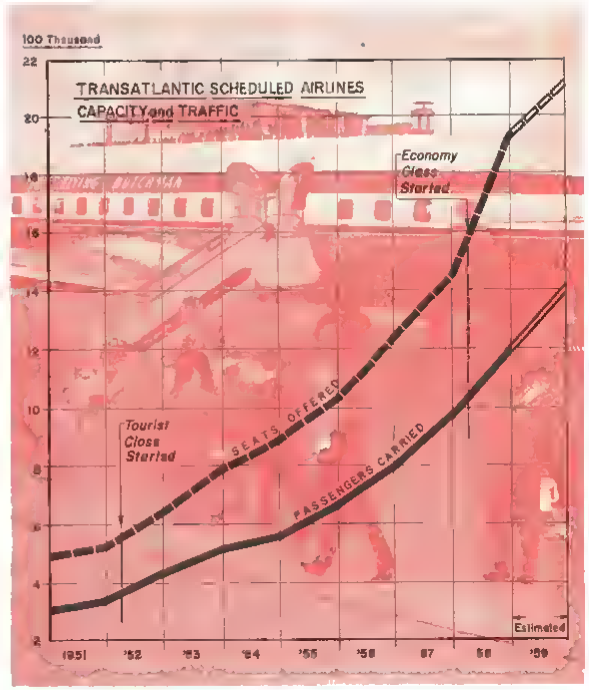
Not all of the carriers are happy to see the growth of charter business, at least during the on season. Some, like SAS, feel that the proper place to handle this growing market for really cheap transatlantic transportation is in the cabins of scheduled airlines at lower than-economy fare prices for special excursion flights.

Travel Agents Unhappy

Travel agents, who provide the great bulk of transatlantic scheduled airline customers are unhappy with the restrictions imposed on them in charter transactions, among them being the prohibition against selling ground tour packages along with charter transportation.

Nevertheless, there is general agreement that charter rates are developing a market among people who wouldn't go at all if the prices were even at the present economy-fare level. And the scheduled carriers are facing increasingly stiff competition from supplemental airlines flying charters on the route.

Last year, the AVIATION WEEK survey indicates, about 50,000 passengers were handled by these supplemental carriers. The total in 1959 may reach 70,000. Along with the scheduled airlines' charter passengers, this would mean a grand total of 220,000 charter rate commercial passengers flying the Atlantic this year.



TOTAL number of scheduled seats available on the North Atlantic rose a record 33% in 1958 over the previous year but probably will increase only by about 10% this year.

The non-scheduled transatlantic operators this year are using a variety of equipment, including Lockheed 749 Constellations, Douglas DC-4 and DC-6 series aircraft, and Boeing Stratocruisers. The Stratocruisers flown on the route last year by BOAC on its first class Monarch service, will be operated this summer by Transocean Air Lines. The supplemental carrier will use four Stratocruisers on the Atlantic with a maximum 100-passenger main cabin and 12 seats in the lower deck lounge. Fare for an 80 passenger configuration will run about $285 per passenger round trip if all seats are sold; in the 100-passenger cabin, fare will be about $220. Transocean handled 31 round trip commercial charters last year; expects to more than double that total this year.

Overseas National Airways, another of the bigger transatlantic charter operators will operate four DC-6As in 80 or 97 passenger configurations. It handled about 60 commercial round trips last year, expects an increase in 1959. Among the charter deals Overseas National has sold is a plush flight for 60 passengers who will charter at the 80 passenger rate and pay about $370 each for the round-trip transportation and $250 for the ground portion of the tour.

Flying Tiger Line

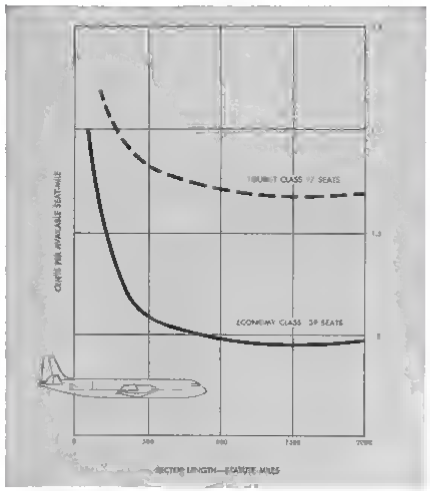
Flying Tiger Line acted last year in the transatlantic charter market to the extent of about 13,000 passengers as practically out of the business this year. Among the reasons cited by Flying Tiger are the need for its Lockheed 1049H Constellation equipment on its domestic scheduled cargo services and military charter contracts. Flying Tiger also points out that back leg return flights on the Atlantic are hard to fill this year because more MATS business has shifted to an annual contract basis instead of a month-to-month bidding situation.

The travel agents feel they have problems not only with the rules under which charters are supposed to operate, but with how the rules are enforced. The American Society of Travel Agents told AVIATION WEEK it had received

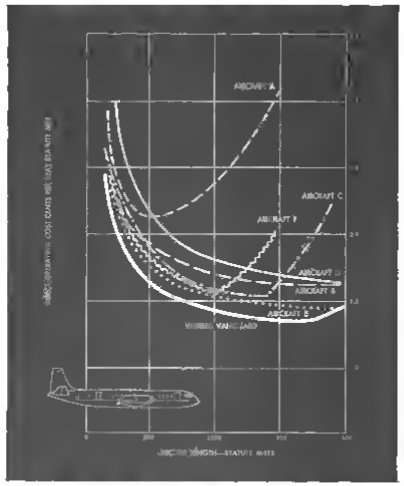
VANGUARD SEAT-MILE COSTS UNDER 1¢

Highest profit potential in airline history

On sectors of 900 to 2000 miles, the new jet-prop Vickers Vanguard offers seat-mile costs *under 1¢* on an economy-class configuration (139 seats). From 100 to 900 miles, costs are below 2¢ with the same configuration. The curves below, based on ATA formula costs, are representative for American carriers.

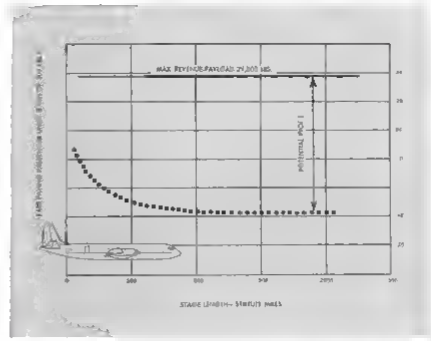


Airline study shows lowest operating costs – The following graph was prepared by one of the world's major airlines. It compares the Vanguard with five other modern airliners (all with economy configurations) and shows the Vanguard by far the most economical.

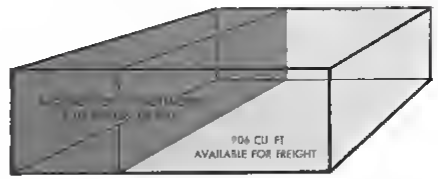


Low break-even means high profit—Because of its low operating costs and its large payload capacity, Vanguard profit potential is the best ever offered to the airline industry. On high-density routes, it will be *at least 35% higher* than that of any comparable aircraft.

The curve in the next graph plots only the passenger break-even load factor.



Large, well-balanced passenger/freight capacity – In addition to its large comfortable passenger capacity, the Vanguard offers a *further* bonus in *freight* capacity. After accommodating all baggage for 97 passengers and 400 pounds of mail, there is still 906 cubic feet available for revenue-earning freight. The Vanguard can be operated profitably during off-peak passenger periods, thus increasing utilization and profit potential.



On some routes, Vanguard is fast as jets—or faster!

STAGE LENGTH — STATUTE MILES	THEORETICAL PURE JET GAIN OVER VANGUARD
200	6 MINUTES
400	11 MINUTES
800	22 MINUTES
1000	46 MINUTES

The chart above shows the comparative block times of the 425-mph Vanguard and a 600-mph pure jet. It is well worth noting that the Vanguard offers all its economic advantages with only the slightest sacrifice in speed on all stages up to 800 miles. In fact, on stages up to 400 miles, the Vanguard will most likely be as fast – or faster – than a pure jet in high-density, day-by-day operations. This is because of the Vanguard's outstanding operational flexibility. It can operate on low-level routing and presents no problems in meeting ATC approach patterns and stacking requirements which, in high-traffic areas, could very well dissipate the marginal speed advantages of pure jets.

And jet speed is expensive. The slight advantage of pure jets on short and medium ranges is outweighed by the wide difference in operating costs: 1¢ per seat-mile at 200 miles, 0.75¢ at 600, 0.65¢ at 1000.

If you would like detailed Vanguard specifications and a complete cost analysis based on your operations, contact Christopher Clarkson, U.S. representative, 10 Rockefeller Plaza, New York 20, New York.

NEWEST FROM THE WORLD LEADER IN JET-PROP AIRCRAFT...

VICKERS VANGUARD

POWERED BY FOUR ROLLS-ROYCE TYNE ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LTD. • WEYBRIDGE, ENGLAND • MEMBER COMPANY OF THE VICKERS GROUP

about 100 complaints during the first quarter of 1959 from member agents across the country, mostly concerning alleged illegal solicitation of charter groups or supposed legal ineligibility of groups that were chartering airplanes.

ASTA would like to see scheduled fares competitive with charter rates. This, according to the agents' association, would prevent the traveling public from "resorting to subterfuge" in obtaining low cost transportation.

Charters operate under Civil Aeronautics Board rules in the case of the supplemental carriers and International Air Transport Assn. rules in the case of the scheduled lines. But since CAB must approve or disapprove IATA resolutions, a disagreement over charter conditions has led to a peculiar situation this summer.

The international association adopted its yearly charter resolution last fall at Cannes, but it has yet to be approved by CAB although it was supposed to go into effect April 1. Meantime CAB has suggested certain revisions to bring the IATA rules closer to its own charter regulations, and has indicated that its approval would be subject to these changes. Among the conditions are rules governing travel agency participation, more precise definition of charter groups, and a definition of immediate family in connection with group eligibility.

Informal Rules

The odd situation now prevailing is that charter transactions are operating as far as IATA is concerned, under no formal set of regulations. IATA is informally going along with CAB's requirements.

Travel agents particularly dislike a new condition prohibiting the agent who books charter transportation from also handling the land tour business of the same group. ASTA last month asked CAB to rescind this requirement and one denying commissions to an agent who is a member or has a member employe of the chartering organization. ASTA also questioned the Board's authority in "indirectly regulating the travel agent industry."

Confusion in the charter operation is further compounded by airline differences as to the proper relationship of charters to scheduled activity.

Some carriers go after them without reservations, while others have basic doubts as to their effect on scheduled business.

In any case, the increasingly important market represented by charter passengers cuts across several issues the carriers face, including the controversy over fare differentials for different types of equipment and the disposition of used piston and turboprop fleets.

Piedmont, West Coast Report F-27 Phase-In Costs Less Than Expected

By Robert H. Cook

Washington—Phasein of Fairchild F-27 turboprop transports by local service carriers may be completed at less than projected costs, according to an analysis of 1958 Civil Aeronautics Board figures for Piedmont and West Coast Airlines.

Piedmont has reported an average F-27 load factor of 63.3% from November to the end of the year, as compared with a predicted 51.42% average by June 30 and a future 55.24% by 1961. Fourth quarter results for the carrier also show direct operating expenses, including flying operations, maintenance and depreciation of only 1.87 cents per seat mile as compared to an expected 2.1 cent prediction (AW Nov. 24, p. 39).

Deducting a depreciation rate of 54.4 cents per plane mile, Piedmont records show that F-27 direct costs reached a low of 1.52 cents per seat mile, based on average available seats of 30.3, as compared with 2.07 cents for the Douglas DC-3.

Break-even load factor, based on present subsidy levels, was announced earlier as 48.5%.

Under a detailed listing of direct expenses for the fourth quarter, Piedmont reported a cost of 31.54 cents per plane mile for F-27 flying operations, 2.3 cents for direct maintenance and 12.70 cents for depreciation. During the same period, these expenses for DC-3 operation amounted to 36.31 cents, 13.37 cents and 1.65 cents, respectively.

West Coast's Experience

Since West Coast began F-27 service last September, the carrier reported a 53.4% load factor on the turboprop by the end of 1958 with fourth quarter results showing direct operating expenses of 2.47 cents per plane mile, less depreciation, as compared to 2.69 cents for the DC-3. The airline's flying operations expense for the turboprops was listed as 52.67 cents per plane mile along with direct maintenance costs of 36.10 cents and depreciation of 21.67 cents.

Comparative figures for West Coast's DC-3s were 48.15 cents, 16.52 and 3.92 cents.

Figures submitted to CAB by the carriers cover six F-27's operated by West Coast and eight by Piedmont. While the costs of West Coast are generally higher than those of Piedmont, both carriers look for future savings in engine maintenance with the expectation that the Federal Aviation Agency will lift the present overhaul ceiling of 700 hr. on the Rolls-Royce Dart 6 engines to meet the 2,000 hr. overhaul time now enjoyed by Viscount operators who utilize the same power plants.

Both airlines have also met with CAB to discuss changes in CAB Special Regulation 422a which restricts the F-27's gross takeoff weight to a point where loads have sometimes been restricted at stations where runway temperatures have reached 87F (AW Mar. 2, p. 30).

Direct Expenses

Direct aircraft operating expenses in dollars per hour for the F-27 were reported at $180.31, including depreciation, for Piedmont and $194.46 for West Coast, with flying operations of $84.57 per hour for Piedmont and $92.80 for West Coast. Direct maintenance cost per hour was listed at $61.69 for Piedmont and $63.50 for West Coast.

Total flying operations cost, based on 209,704 mi. flown during the period by Piedmont and 416,455 by West Coast, was $66,132 and $217,697, respectively. Total direct maintenance expenses of $48,244 were recorded by Piedmont, and $148,978 by West Coast.

During 1958 Piedmont achieved an average daily utilization rate of about 5 hr. for the F-27 for a fleet total of 782 hr. at an average flight speed of 202 mph. and a fuel consumption of 345.5 gph.

In comparison, West Coast's utilization rate on the turboprop was 4 hr., 33 min. for a fleet total of 2,346 hr. at an average speed of 177 mph. and a fuel consumption of 280.4 gph.

Since submitting its fourth quarter reports Piedmont has reported increasing its F-27 daily utilization rate to six hours and West Coast to seven.

TWA Completes First Reorganization Phase

New York—Trans World Airlines has completed the first phase of its reorganization program (AW April 12, p. 36) with the creation of several new offices and the realignment of others. Chief objectives of the plan are to separate policy making and planning from day-to-day operation.

A new position of system general manager, with responsibility for all line

BEA Vanguard to Make First Overseas Flight May 6

British European Airways' Vickers Vanguard (left) is the first of 20 ordered by the airline. It will make its first overseas flight May 6 to Hamburg, Germany. First flight was April 22. Vickers' first production Vanguard (right) has flown 120 hr. since its initial flight Jan. 20, an average of 1 hr. 20 min. per day. The Rolls-Royce Tyne turboprops are rated at 5,500 shp. each.

operation, will temporarily be filled by TWA President Charles S. Thomas. Other innovations include creation of a department of planning and research, a department of equipment retirement to market piston aircraft, and a scheduling department.

New officers of the company are Floyd D. Hall, vice president-flight operations; E. Paul Burke, assistant vice president and executive assistant to the general manager; Henry D. Fellows, assistant vice president-schedule planning and market research; Alfred E. Jordan, assistant vice president-maintenance and engineering; John T. Logan, assistant vice president-scheduling; and Russell K. Rourke, assistant vice president-equipment planning and development.

Under the realignment of officers, Frank E. Busch becomes vice president of the department of equipment retirement; Raymond M. Dunn becomes vice president-technical services; Thomas K. Taylor becomes vice president-Washington with an interim assignment as special assistant to the president; and Robert W. Rummel becomes vice president-planning and research.

Electra Vibration Fix Proposed

Washington—Elimination of excessive vibration in Lockheed Electra (AW Feb. 23, p. 37) appears likely as a result of manufacturer's tests which last week indicated raising the engine angle of attack as a major fix.

Changing the engine thrust line from its former position of one degree nose down, below the fuselage reference line to a tilt-up position of two degrees above, has reduced propeller inflow loads formerly transmitted back to the engine nose gear box, according to the latest Lockheed engineering studies. Attendant reduction of the airflow angle lowers vibration formerly encountered by the fuselage at the propeller plane and is expected to affect maintenance through better parts life expectancy.

In conjunction with the engine modifications, Lockheed also expects to modify the present propeller synchrophasing on the Electra by changing the angles of propeller blades to maintain the same level of power while lowering the noise level.

Although Lockheed says these are the major changes needed to solve the vibration program, the company is continuing its flight test work to determine the need for any further refinements. Actual flight test of the modified Electra is hoped to be completed in time for Lockheed to acquire an amended approved type certificate by the end of this month.

Company spokesmen estimate that Electras leaving the assembly line in mid-July will contain the modifications indicated by the vibration tests, and that a field program of modifying and retrofitting planes already delivered will be conducted simultaneously. Down time was estimated at five days per aircraft for the changes.

Lockheed also emphasized that the changes will not delay deliveries.

Whitlock Moves

Washington—Capital Airlines last week announced the appointment of Marvin Whitlock, former vice president of American Airlines as senior vice president for engineering and maintenance. Whitlock is the third American Airlines officer to move to Capital in an executive capacity in the past year.

Earlier Retirement Urged for Pilots

Los Angeles—Age/efficiency factor may force a lower retirement age for airline pilots, according to Dr. John E. Smith, acting chief air surgeon for the Federal Aviation Agency.

At the Aero Medical Assn. conference here, Dr. Smith recommended mandatory retirement at age 60 and possibly earlier, if in the opinion of physicians a pilot showed signs of performance deterioration. He estimated that there are presently 30 pilots over 60 now flying actively with the airlines and seriously questioned the ability of a man in this age bracket to cope with newer high performance aircraft.

Anticipating bitter opposition from the Air Line Pilots Assn. to any regulation which would force early retirement, Dr. Smith admitted that revoking a pilot's license, thereby depriving him of his livelihood, is a matter for serious concern. However, he said that FAA could not stand by and permit ALPA and the airlines to haggle over human lives at the bargaining table. Even though a man of age 60 may be of robust health, Dr. Smith added, his ability to cope with new aircraft and attendant changes in procedure may be impaired by decreased efficiency, resulting in a lowering of the age/efficiency factor. This age problem will increase since, he estimated, by 1970 1,500 airline pilots will be age 60 or over.

Federal Aviation Agency also expects to adopt a 'get tough' policy with private and other commercial pilots by increasing physical standards. Both medical examiners and corporations employing pilots have been apathetic regarding physical standards in the past, he said.

Airline Traffic—February, 1959

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	513,492	353,662	63 6	1 631,388	737,535	7,120,370	43 529 393	56 4
Braniff	164,591	69 850	60 6	304,812	161,548	503,055	7,674 802	50 3
Capitol	268,141	116,364	56 7	429,562	206,877	277,399	12,869,632	46 3
Continental	59,942	28,729	47 6	90,802	42,513	136,745	3,034 499	42 6
Delta	220,767	114,072	57 1	381 023	225 373	1,073,013	12,677 213	51 6
Eastern	586,627	344,678	53 17	906,130	422,785	1,112,894	35,721 912	49 46
National	153,243	106,694	62 2	314,821	66,889	572,809	11 342 633	49 5
Northeast	82,059	43,762	53 4	113,997	29,426	103 376	4,443, 526	43 2
Northwest	316,768	88,453	48 2	495,045	213,803	1,103 452	10 319 761	42 5
Trans World	331,185	266,897	60 5	1,183,777	599,202	2,080 203	29,426, 828	54 6
United	478,945	327,539	58 4	2,533,772	836,907	5,272,734	40 179,176	53 7
Western	108,452	56,954	58 0	244,999	74,987	268,627	6,852,998	49 2
INTERNATIONAL								
American	11,359	12,598	79 4	10,341	455	240,777	1,554,174	73 0
Braniff	3 450	6,455	47 7	15,301		98,872	819,653	44 2
Caribbean-Atlantic	28,884	2,062	70 7	1,681		4,502	225,387	77 8
Delta	3,635	4,151	44 3	6,748		42,103	512,593	40 1
Eastern	30,431	44,606	54 99	95,941		120,993	4,853,840	54 39
Mackey	9,822	7,992	41 0		234	2,794	217,996	40 9
National	6,077	4,559	53 6	7,043	2,740	34,581	529 157	46 6
Northwest	9,240	20,296	45 4	1,354,253	22,070	798,441	4,359, 861	63 7
Pan American								
Alaska	1,905	1,985	26 7	21,536		107,935	345,889	37 6
Atlantic	61,208	85,059	59 0	1,194,866		2,241,692	12,531,193	56 0
Latin American	100,919	102,083	69 0	345,107		4,263,960	14,923,135	69 7
Pacific	22,013	85,059	75 5	1,235,063		1,761,628	11,836,725	68 4
Panagra	10,798	15,226	64 5	62,424		432,246	2,153,857	67 1
Resort						4,064,290	4,064,290	79 7
Trans-Caribbean	6,423	10,258	67 3			119,187	951,142	66 2
Trans World	21,533	65,416	67 0	856,599		1,803,231	9,430,139	67 7
UMCA	186	61	45 2			724	7,892	67 5
United	6,733	16,728	58 0	131,312		76,665	1,921,631	57 0
Western	4 052	6,308	64 2	6,018		14,615	689,338	66 1
LOCAL SERVICE								
Allegheny	30,752	5,257	42 2	10,256	18,986	17,610	548,621	42 7
Bonanza	15,777	3,743	52 1	5,389	1,899	7,122	372 963	50 1
Central	11,223	2,258	35 7	6,022	3,241	10,580	236,358	32 7
Frontier	17,720	4,281	42 2	17,684	7,008	49,174	485 493	50 3
Lake Central	13,989	2,217	39 2	3,335	11,943		227,538	42 6
Mohawk	35,512	6,768	54 8	8,498	10,919	11,684	676 256	54 7
North Central	54,093	8,785	45 2	25,590	30,853		900 538	46 3
Ozark	31,353	5,449	47 1	9,146	14,426	15,625	559 295	49 0
Pacific	29 008	6,467	48 8	10,620	3,978	8,257	639 742	47 0
Piedmont	30,422	6,251	40 2	13,223	10,454	10,453	633 231	40 6
Southern	16,454	2,901	35 2	8,629	9,549	8 802	305 303	35 4
Trans-Texas	18,002	4,118	41 1	13,827	7,227	22,994	438 369	41 9
West Coast	22 325	4,327	46 64	4,914	2,077	7,601	427, 838	45 25
HAWAIIAN								
Aloha Airlines	12,538	1,717	55 5	650		5,375	143,642	54 9
Hawaiian	29,022	4,368	58 94	4 209		100 161	454 758	58 76
CARGO LINES								
AAXICO				10,227	18,257	3,041,244	3,869 728	75 5
Aerovias Sud Americana						459,930	459, 930	87 0
Flying Tiger	1,207	5,814	188 8	32,941	42,485	8,479,020	9,135,908	86 0
Riddle								
Domestic				6,432	24,099	3,498 153	3 528 684	74 8
Overseas						654,245	654,245	69 5
Seaboard & Western	670	2,725	188 8	318,262		3 279,194	3,888,834	65 3
Slick	2,760	17,577	92 03				1,757 673	92 83
HELICOPTER LINES								
Chicago Helicopter	8,106	152	35 4	1,035			15,509	30 6
Los Angeles Airways	2,219	85	48 6	3,986	2,031		14,139	54 6
New York Airways	6,296	124	36 9	1,307	1,242	559	14 972	39 3
ALASKA LINES								
Alaska Airlines	5,193	2,708	36 8	61,371	2,540	142,960	485,999	36 3
Alaska Coastal	2,586	242	56 3	3,927		2,866	31 518	64 9
Cordova	739	96	37 5	3,321		31,091	44 354	43 5
Ellis	3,036	185	55 9	1,623		1,757	22 389	67 5
Northern Consolidated	1,190	400	46 7	23,072		29,302	97,263	62 6
Pacific Northern	6,192	5,434	37 6	94,938	5,557	176,732	866,963	48 5
Reeve Aleutian	699	617	31 3	31,699		80,961	181,436	53 8
Wien Alaska	2,174	540	14 4	32,024		246,648	334,324	58 1

Compiled by Aviation Week from airline reports to the Civil Aeronautics Board

This is *the* year to enjoy the richness of Europe through the magic of Pan Am Jet Clippers.

Over 50,000 transatlantic travelers have discovered the secret of Jet Clipper magic

Experienced travelers know what it means to be able to fly to Europe in nearly *half* the time with more than *twice* the comfort. This is the Jet Clippers' secret for making friends, and keeping them.

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FIRST ON THE ATLANTIC ... FIRST ON THE PACIFIC ...
FIRST IN LATIN AMERICA ... FIRST 'ROUND THE WORLD

PAN AM

WORLD'S MOST EXPERIENCED AIRLINE

The Boeing 707 Jet Clippers are the most thoroughly flight-tested aircraft ever to enter commercial service.

AIRLINE OBSERVER

▶ Look for renewed interest in a turboprop conversion of the Douglas DC-7. Napier Engines, Inc., officials have discussed several programs with Douglas which offer a wide range of conversion opportunities. Civil Aeronautics Board also is evidencing interest in conversion plans now in effect or under discussion.

▶ Pan American World Airways is revamping its entire spring transatlantic schedule because of a temporary restriction imposed on turbojet operations at the London Airport by British authorities (AW April 27, p. 41). Carrier says it is contacting a total of 15,000 passengers whose reservations will be affected by the change in schedules which were to have been effective April 26.

▶ Watch for West Coast Airlines to order three more Fairchild F-27 turboprop transports. Initial experience with the aircraft has demonstrated that the F-27 is quite compatible with the carrier's route pattern (AW April 20, p. 49).

▶ Official Red Air Force newspaper Sovetskaya Aviatsiya says American Boeing 707 and Lockheed Electra transports have "failed to live up to their high-pressure publicity buildup." Conceding that the 707 and Electra are fast and comfortable—"as befits craft designed primarily to carry people with fat pocketbooks"—the Soviet publication states that events have disproved claims of operational reliability.

▶ Local service airlines' load factors continued to rise during March. Overall load factor for six local service airlines climbed 1.82 points over March 1958, with Bonanza, Lake Central and Allegheny showing the largest gains. Bonanza reached a load factor of 60% for the month, a 9.15% increase over the same month last year.

▶ Allegheny Airlines has leased one Canadair 540 turboprop transport from Napier Engines, Inc., for a three months period beginning July 1 to be used in scheduled operations on its Pittsburgh-Atlantic City-Washington route. Experience with the aircraft during the evaluation period will determine "the size and the timing of any order" the carrier may place for turbine-powered equipment. Initially, the airline will operate three daily round trips with the 540 between Pittsburgh and Atlantic City and one daily round trip between Atlantic City and Washington.

▶ Trans World Airlines reports a 96% load factor on Boeing 707 flights operating between San Francisco and New York. Turbojet service, which began Mar. 20, will be expanded to include first jet service between San Francisco and Los Angeles May 29.

▶ Federal Aviation Agency air carrier inspectors will receive flight and ground training on the Boeing KC-135 turbojet aircraft at the Merced, Calif., Air Force school. Total of 13 inspectors, assigned to certification of airline pilots, will take the flight course.

▶ Airlines are evaluating a special "emergency announcement tape recorder" device for installation on aircraft. Purpose of the equipment is to provide passengers with any announcements of emergencies automatically without diverting pilots from flight duties. For example, a recorded announcement instructing passengers to use oxygen masks would be automatically activated by a failure of cabin pressurization during flights at high altitudes.

▶ Pan American World Airways will make a bid to enter turbojet cargo operations. The airline is talking with leading U. S. manufacturers on the possibility of developing large cargo turbojets of intercontinental range that would cut cargo rates in half and permit the transport of ordinary mail and parcel post by air. In his report to stockholders, Pan American President Juan Trippe said "a fast jet especially designed for cargo, could handle five times as much cargo as present day piston engined aircraft."

SHORTLINES

▶ Eastern Air Lines has completed construction of a 2,205,000 gal. underground jet fueling system at Miami International Airport at a cost of $1,250,000. The system will be able to pump 11,000 gpm. to the 22 Eastern positions at the new terminal building. As Eastern's fleet of jet aircraft increases, the capacity of the storage area will be increased to 5,000,000 gal.

▶ Canadian Pacific Airlines reports a net year end 1958 loss of $1.9 million, compared with a net loss in 1957 of $113,000. A major reason for the increased loss figure is a decrease in sales of aircraft, buildings and equipment in 1958, which was down from the 1957 figure of $1,545,000 to $412,000 for last year.

▶ Iberia Air Lines of Spain will reopen its route back into Mexico during May, after a five year lapse in service. Iberia has reached agreement with Mexican authorities to reinstate the route operating from Madrid to Lisbon, Bermuda, Havana and Mexico City.

▶ Pan American World Airways flew its 50,000th flight across the Pacific Ocean on April 29. PanAm began Pacific operations on Nov. 22, 1935.

▶ UAT French Airlines carried 190,000 passengers over 640 million revenue passenger miles during 1958, increases of 25.2% and 17.3% respectively. Air cargo volume in 1958 was 26,400,000 lb., amounting to 92 million ton miles. UAT serves Paris, Nice, Marseilles and Bordeaux in France and numerous cities and stops in the Middle East and Africa.

▶ Panagra is now offering combination first and tourist class service on all its flights between the U. S. and key South American cities. All of Panagra's Douglas DC-7 and DC-6B equipment now has been fitted out in the dual configuration.

▶ Moscow's proposed new Kazan Station post office building will have a rooftop heliport for fast mail transportation to and from the city's commercial airports.

▶ Lake Central Airlines reports a 30% increase in passenger boardings during the first two weeks of April as compared with the same period last year. The month of March recorded a 19.4% increase over March, 1958, with the first quarter, 1959, percentage increase up 11.7% over the January, February, March period in 1958.

British Weigh Entering Supersonic Race

By John Tunstall

London—The British aircraft industry must enter the supersonic airliner race if it is to survive, according to opinions expressed by top management, production and design officials in discussion at a conference arranged by the Institution of Production Engineers at Southampton.

But if it does, the recent recommendations that the government should proceed with two relatively slow-speed supersonic aircraft and not with a Mach 3 vehicle (AW April 20 p. 43) were condemned as "commercial nonsense" by Peter G. Masefield, managing director of Bristol Aircraft Ltd. and president elect of the Royal Aeronautical Society.

There is a grave danger, he said, that to enter this field "too slow or too late" could lead to the total loss of the money expended. This he said, could reach to $420 million each for the development of two types of airliner, to the certificate of airworthiness stage. And Britain's share of a total world requirement of 40 aircraft would not exceed 10, he estimated.

Time and time again during the discussion and in subsequent radio interviews, Masefield pleaded for a new committee having unprecedented power and including representatives from a wide field of commerce and the treasury to review with the utmost urgency the entire status of British aeronautics.

It was an "inescapable fact," Masefield predicted, that unless a forward policy for British aeronautics was implemented with adequate government backing forthwith Britain would "fall behind forever" in maintaining her position as a world power. "There has never been such a time of decision," he added.

Industry Collapse Foreseen

The discussion, which resolved into whether Britain could enter this field in competition with the United States, followed the presentation of three papers on the theme "The Aircraft Industry—a National Asset." Several prominent industry authorities warned that unless Britain did commit herself very soon to a supersonic airliner project, the aircraft industry would quickly collapse.

On the other hand, not all the speakers believed that that was Britain's only course. It was futile, they said, to meet American competition head-on in this field.

It was possible that the aircraft requirements could diverge into two completely distinct categories. One would operate at high supersonic speeds and with relatively high aircraft mile costs and the other with low costs, a higher frequency, and at moderate subsonic speeds. It was in this field—medium-range subsonic jet airliners—where the United States has not heavily engaged, that perhaps Britain's future lay.

Its objective could then be the development of the mass market with this type of aircraft together with a new family of freighter aircraft and helicopters. Fares could be slashed to one-third their current value during the development phase.

Britain certainly could not tackle both categories of aircraft.

Envisaged was a subsonic Viscount-Convair arrangement for which a market worth several hundred million pounds was forecast. In this category Bristol is engaged with the Bristol 205 which has a twin-engine mounting at the tail and the de Havilland DH 123 with a STOL device, and probably de Havilland Gnome engines. Held up for lack of government support is the Handley Page laminar flow jet airliner which though only of 30,000 lb., has a medium range capacity due to its low drag characteristic.

Licensed Production

An alternative policy and one which should be rigorously pursued, according to Peter Masefield, involved Anglo-American collaboration, in the supersonic field. An acceptable arrangement might be the building of an American design under license, with British engines.

The real issue, however, and one clearly appreciated at the conference, turned on whether a manufacturing nation such as Britain could remain a first-class power without an extensive aircraft industry. A completely disproportionate part of the technological advance in all British industries in design, production management and inspection since the war could be attributed to the aircraft industry directly or indirectly.

The collapse of this particular industry could decimate in the long term the whole of Britain's industrial effort. Outside the aircraft industry (and excluding the nuclear field) the objectives or stimuli for research are not so tangibly or dramatically displayed, nor so rigorously pursued. Often, when research or development is not urgent, or is long term, it doesn't get done at all and several speakers cited Britain's shipbuilding and civil engineering industries among those declining because of this attitude.

The target for the aircraft industry was the supersonic airliner and it seemed generally agreed at the conference that it was unprofitable, if not useless, to engage in advanced aerodynamic research without it. Consequently it was feared the industry would soon dissipate its present strength and lose its key personnel if it were forced to concentrate in the subsonic regime where the problems were mostly solved.

Market Potential

The conference was also reminded that the United States was not likely to assure the British aircraft industry that it would remain permanently disengaged from the medium-range jet airliner because of Britain's predicament. It was, after all, that part of the spectrum—possibly the only part—where real profits would be in the future. The total world requirement of supersonic airliners will not exceed 40, Masefield estimated.

Furthermore the loss of prestige incurred by withdrawal from the supersonic field could seriously prejudice not only the sale of its subsonic aircraft assuming the likelihood of severe competition from Russia and the United States but could well reflect unfavorably on British exports in general.

"The basic issue—whether we like it or not—" Masefield said in his paper "The Industry Point of View," "is whether the aircraft industry in the United Kingdom can remain much longer in the 'big league' of military and civil aeronautics. Let us be clear that the 'big league' means expenditures on ballistic missiles, anti-ballistic missiles, supersonic transports, VTOL aircraft, perhaps nuclear powerplants later on, and a comprehensive research program."

It was summarized, he said, by the urge to develop two supersonic airliners which would cost approximately $420 million each up to the certificate of airworthiness stage. "Can we afford it? Can we afford not to do it?" queried Masefield.

He brought out another serious problem affecting aircraft industries on both sides of the Atlantic—"the check in the ability of airlines to order new aircraft at a sedate but continuous pace sufficient to keep in steady employment design teams and production staffs upon whom future progress must depend."

Elsewhere Masefield showed that by operating on 10 times the scale of the British aircraft industry and because of its longer production runs, U.S. aircraft are even less expensive than British aircraft in spite of America's high labor cost. He gave figures for sub-

Continental's First 707-120 Delivered

Continental Airlines has received its first Boeing 707-120 jet transport. The airline will begin nonstop flights between Los Angeles and Chicago June 8 with four 707-120s, all of which are expected to be delivered this month (AW April 13, p. 47).

sonic jet aircraft on the order of $40 per pound British against $38.40 per pound American.

"Once supersonic passenger flight is achieved there is no foreseeable end to the technical race," Masefield said. "The question bears repeating—should we now decide to engage in this race? If we do, the cost will be very heavy, but it may perhaps demonstrate the level of our national technical competence. If we do not, we shall be out of this particular competitive field for all time."

The question could be answered, he thought, only against the most fundamental and widespread government review of the whole status of British aeronautics. "What is required," Masefield emphasized, "is a new Brabazon-Cadman type committee at a high level sitting under an unbiased chairman who would command respect on all sides. It must number among its members representatives of industry, of commerce, the airlines, the manufacturers, the research establishments, economists and the ministries of supply and transport and the treasury.

"Only from such a study can the path ahead be determined with force and logic.

"One thing is quite clear. It is useless to tinker with these problems. We must get on—in selected spheres—or we must get out. If we decide to undertake specific tasks we must allocate adequate funds and research and manufacturing effort at them. Otherwise we must leave them alone. In aeronautics—as in any technical task worth attempting—once the sphere is defined it must be an all out effort—or nothing."

Masefield listed six points in the government resolution of Britain's aircraft industry's predicament:

- **Policy** of a strong British aircraft industry should be established with clear objectives, within the financial terms decided.
- **Defined field** of endeavor should be set in the aircraft fields of transport, general aviation, manned military aircraft, guided flight and helicopters. Within each category clear—if limited—targets should be set in both civil and military fields.
- **State-sponsored** research and development programs should be planned within the specifically defined areas.
- **Final support** for a series of major projects should be determined—on the principle that what is worth doing at all must be done adequately—that research without production is useless.
- **Responsibility** of the state airways corporations for initiating the development of British aircraft to meet their future needs should be defined again with clarity and supported with money.
- **Policy** of encouraging British aeronautics generally should be established with particular reference to both the independent operators and to general aviation, thus leading from the foundation of a healthy home market to expanding export sales.

The effect of future Soviet competition and the impact of the European common market on Britain's aircraft industry were among other topics aired at the conference.

The conference was assured that Soviet aircraft sales were not likely to be significant in the West. "We have learned ourselves," one manufacturer mused, "how difficult it is to get full certification for one's aircraft in other lands." What the Russians might well do, said one prominent management official, would be to mount some airline opposition with its giant, long-range and high-economic Tu-114, and break the IATA fare structure. "This would be the best thing the USSR has done for years."

Other speakers at the conference thought the development of the common market could be "disastrous." Britain was losing out fast in Europe, named one manufacturer, because of a lack of political awareness, and a failure to get in the act.

BEA Load Factor Drops, Passenger Miles Increase

London—British European Airways has marked up its fifth consecutive profitable year despite the recession in air traffic last year, according to preliminary reports.

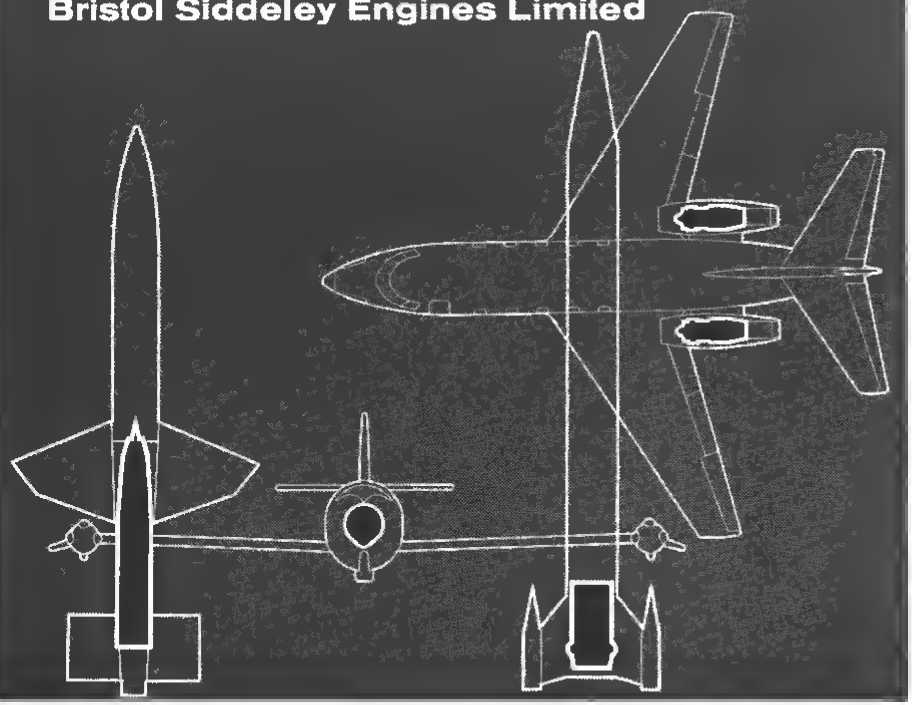
Lord Douglas, BEA board chairman, reported passenger miles flown increased 5.6% compared with an average increase of 16% in the previous 10 years.

The load factor dropped from 68.5% to 62.5%.

Annual income was aided by Easter holiday traffic which set new records, topping the previous 1957 high by more than 3%.

BRAIN POWER

Bristol Siddeley Engines Limited



THE CHALLENGE. The changing face of aviation demands further development of established powerplants; demands design of new forms of power, demands the right engine at the right time in the right quantity

ANSWERED BY A GREAT NEW COMPANY
Bristol Siddeley Engines Limited allies the minds, skills, resources of Bristol Aero Engines and Armstrong Siddeley Motors to form a new giant of immense capability, immediately equipped for a dominant role in world aviation

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ORPHEUS—leading lightweight medium-thrust turbojet . . .

FLIGHT POWER

already specified in 8 countries for 14 different aircraft including the outstanding Lockheed Jetstar

SINGLE MAMBA—jet prop . . . stressed for naval operations such as deck landing and catapulting . . . installed in the Short Seamew

THOR—a fully developed ramjet engine . . . powers the Bristol/Ferranti Bloodhound guided missile system chosen as Britain's major air defence weapon, ordered by Sweden

GAMMA ROCKET MOTORS—developed and produced as the power unit of the successful Black Knight research rocket

OLYMPUS—turbojet . . . remarkable for great power at high altitude and very low fuel consumption . . . powerplant of the Avro Vulcan bomber

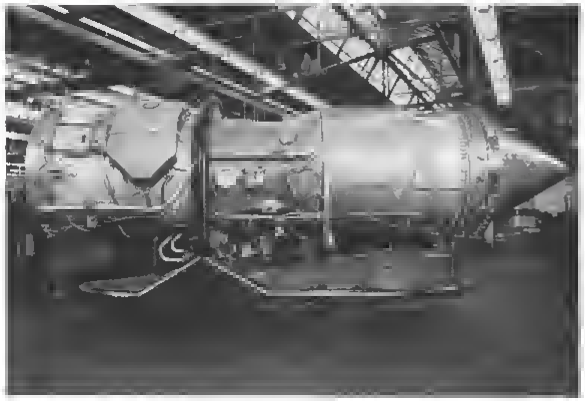
DOUBLE MAMBA—jet-prop . . . virtually twin-engined reliability for long overseas reconnaissance duties . . . powers the Fairey Gannet

CENTAURUS AND HERCULES—two radial piston engines with Bristol pioneered sleeve valves . . . renowned for their reliability and long overhaul life

P181, P182—turboshafts . . . remarkably compact for power developed . . . P181 designed for helicopters, P182 for fixed-wing aircraft

Bristol Siddeley
ENGINES LIMITED

BRAIN POWER translated into FLIGHT POWER



JT4A-3 commercial engine on dolly is one of the first production models ready for delivery this month. Engine has about same outside measurements as JT3 (J57) but its hub-to-tip ratio is smaller and it is more powerful, handling more air

FLIGHT TESTING of the JT4 engine has been conducted for the past 16 months by Boeing in the 367-80 aircraft (above), the original experimental model of the 707. Over 466 flight hours have been accumulated. Developmental JT4 is mounted in the inboard pod (above) which is slightly larger than the outboard pod which houses a JT3 turbojet. Close-up of the JT4 pod is below. Turbofan versions of the JT4 will exhaust fan air well forward on the nacelle. Fan air exhaust will be approximately where forward cowl ends in the picture below

JT4 Designed for Growth as Transport Size Increases

By J. S. Butz, Jr.

East Hartford, Conn.—Pratt & Whitney Aircraft Division of United Aircraft Corp., scheduled to deliver its first production JT4 commercial version of the military J75 turbojet engine sometime this month, has moved to meet an expected growth in the size of subsonic jet transports by planning a 50% growth factor into this basic engine design during the next few years.

Family of JT4 engines as laid out by Pratt & Whitney includes four versions, culminating in a 25,000-lb.-thrust turbofan. All of the advanced engines utilize a large percentage of parts from the first production model, the JT4A-3, which has a rating of 15,800 lb. thrust.

JT4A-9 Delivery

Second engine rated at 17,500 lb. thrust and designated the JT4A-9 should be available by the middle of next year. Only parts replacement required to convert the first JT4 model to this more powerful version are the turbine inlet nozzles and the first two turbine stages. Thrust improvement will be gained primarily through use of more advanced materials in these parts.

Third engine in the family will be a 22,500-lb.-thrust turbofan, the JT4D-3. This engine will utilize the fan section from the JT3D-1 (turbofan version of the J57 military engine). While the JT4 is much more powerful than the JT3, it is possible to use the same fan section on the front of both engines because the inside diameter of the air path in their compressor sections is about the same. Reduction in cruise specific fuel consumption will be about 8%, using this JT3 fan on the front of the JT4. It also will be necessary to add a fourth turbine stage to the engine to provide sufficient power to the fan section.

Last engine in the family will be a turbofan of 25,000 lb. thrust with the fan section designed especially for the JT4. This fan section will have a bypass ratio of about 1.5, indicating that 1.5 times more air passes through the fan than through the main part of the engine. Specific fuel consumption with this engine will be reduced by between 12 and 15% in comparison with the first JT4 production model, the -3.

Reason the second turbofan version of the JT4 will have better fuel consumption than the first is its higher bypass ratio. The JT3 (J57) fan section with its smaller outside diameter provides a bypass ratio of only 0.8 as opposed to 1.5 for the larger engine, and fuel consumption on a turbofan depends almost directly upon this bypass factor.

While the first two engines in the JT4 family are in production or well along in their development cycle, the second two have not yet progressed beyond the preliminary design stage. Detailed design and development of these fan engines will not be pursued by the company unless military interest is shown or large airline orders are received.

In the majority of cases in the past, the most appealing engines commercially were developed by the services and spent long years in military use before appearing in the civil market. This pattern has appealed to the airlines because they can buy proven engines which are less expensive since a major percentage of the development costs have been amortized during the military program.

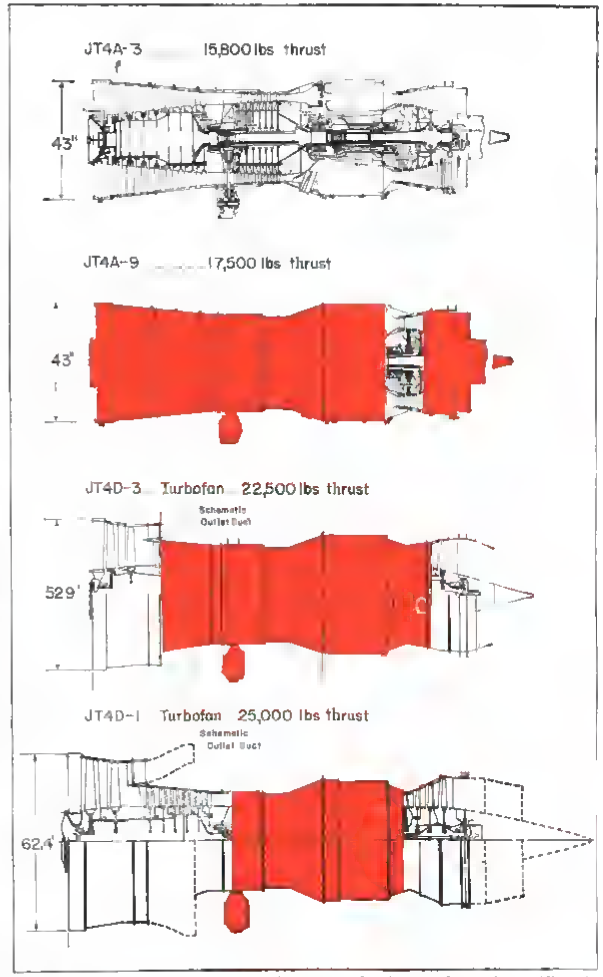
None of the engines in the JT4 family have been developed under these circumstances. The J75 military counterpart of the JT4-3 now ready for commercial service has not been in use for any extended period in any aircraft. Various versions of the J75 are installed in the Martin P6M-2, Republic F-105, and Convair F-106, none of which is high-time aircraft as yet. Experience also was gained in the North American F-107, Chance Vought F8U-3 and the Avro CF-105 before they were terminated.

Pratt & Whitney followed two main courses to compensate for its relative lack of running time and prepare the JT4 for commercial sale:

- Service experience with the 10,000-lb.-thrust-plus J57, which has several years of extensive military use behind it, was crammed immediately into the J75 and JT4 programs.
- Accelerated tests were run on the engines by the Air Force, Boeing Airplane Co. and Pratt & Whitney.

Aid from J57

It was possible to make rapid and significant use of the J-3 (J57) experience in the J75 program because of the great similarity between the engines. Both have twin spool compressor sections; they use the same materials and general design techniques; their compressors have the same high compression ratio of about 12 to one in order to achieve the best possible fuel consumption in the high subsonic speed range, and both have approximately the same



PLANNED GROWTH of the JT4A-3 (J75) commercial turbojet is shown above. All of the engines in this family use major parts assemblies from the original -3, these are shown in red. Conversion to the more powerful versions of the JT4 may be made in an overhaul facility without rework of the sections in red. First turbofan, the JT4D-3, uses the forward fan section from the J-3 (J57) turbofan which is now in development. This engine reduces specific fuel consumption about 8%. Fan section designed specifically for the JT4 used in the bottom engine will reduce fuel consumption 15% over the JT4A-3. Bottom two engines will not be taken past preliminary design until a commercial or military requirement is established. The JT4A-3, the first production engine, weighs 5,020 lb.

turbine inlet temperature The J14 has a lower hub-to-tip ratio and a larger air capacity which accounts for its greater power

Primary difference between the design of the engines, however, is that the J75 must be more sophisticated to achieve a similar thrust-to-weight ratio, since it is easier to achieve a high thrust-to-weight ratio with a small engine than with a large one

Evidence that J57 information has been put to maximum use in the J75-JT4 programs is the fact that the thrust-to-weight ratio of the first JT4 engines is about 3 1 at takeoff This is approximately the same as the thrust-to-weight ratio of the latest model of the J 13

In effect, the J75 and JT4 engines were absorbed into and received the benefit of the long modification and testing program of the J57 and the J13. This modification and testing program is the heart of Pratt & Whitney's philosophy concerning the development of engines

Development Philosophy

First precept of this philosophy is to make the initial experimental engine of any series a rather heavy, conservative engine designed so that there is as little doubt as possible about its functioning Several of these experimental engines are then constructed and test run as much as facilities will permit

It is believed by Pratt & Whitney engineering that the large number of hours and mass of data which can be rapidly accumulated on such experimental engines makes it possible to develop a good operational engine in the shortest possible time All major problem areas are usually pinpointed during this extensive prototype testing program, and the data collected is used immediately to lighten and improve the design

For example, the thrust-to-weight ratio of the J13 prototype in 1951 was around 2 0 On the first production engine two years later it has been improved to about 2 22 This development program has been continued without letup and the thrust-to-weight ratio of the latest version is better than 3.0

Pratt & Whitney management has helped make this development philosophy effective by providing probably the largest privately owned facilities in the world for the experimental testing of engines under all operating conditions Primarily grouped within the Willgoos Laboratory, these facilities represent a capital investment of more than $100 million.

The J75 JT4 program also has had the benefit of some unusual accelerated testing to compensate for its limited operational military use Pratt & Whitney has taken one JT4 engine through three consecutive 1,000-hr tests and has just begun a fourth series Each of these 1,000-hr tests is conducted to approximate airline operation with periods of taxi, takeoff climb, cruise, let down power etc corresponding to trips of from three to seven hours The engine has been torn down inspected and given a major overhaul after each 1,000 hr of running

No major trouble has developed even in the first of these 1 000 hr tests

The Air Force also has built up time on the J75 by flying it in a modified Boeing B 52 with J75s in the outboard pods replacing the two J57s

Boeing began flight testing the JT4 in December 1957, by installing one in a pod of the original experimental 707

four hundred and sixty six hours have been logged by this aircraft since it began flying with the JT4

Major difference between the JT3 and JT4 designs is in the first four compressor stages The rotating blades in these stages had to be longer on the JT4 than on the JT3 yet their weight could not be greater if the prescribed thrust-to-weight ratio was to be met To solve this problem, Pratt & Whitney used a single pin to hold the blades rather than the more customary fir tree attachments on the JT3 The blades were made of titanium so that their base could be narrow and the pins would provide an adequate at

Pratt & Whitney J75 and JT4 Specifications

First detailed specifications of military and civil versions of Pratt & Whitney Aircraft J75 series turbojet, recently cleared by Department of Defense, show current military versions with power ratings from 15,800 lb. thrust to 26,500 lb. thrust (with afterburning and water injection) and civil models ranging from 15,800 lb. thrust to 16,800 lb. thrust.

Manufacturer	Designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power @ S.L.	Specific fuel consumption at max. power, lb. /hr. /lb. or equiv.	Compression ratio at max. rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less gallons, lb.	Remarks
United Aircraft Corp.	JT4A-3 -5	AFJ	16	4	8	15,800	0.85	12	43	114.1	5,020	—5 weight, 4,815 lb.
Pratt & Whitney Aircraft Division, Hartford, Conn.	JT4A-9 -10	AFJ	16	4	8	16,800	0.81	12	43	144.1	5,060	—10 weight, 4,845 lb.
	J75-P-2	AFJ	15	3	8	15,800	0.77	12	43	146.4	4,800	Non-afterburning JT4A-1
	J75-P-17	AFJ	16	3	8	24,500	2.15	13	43	237.6	6,675	Afterburning JT4A-28
	J75-P-19W	AFJ	16	3	8	24,500	2.15	13	43	258.3	5,960	Afterburner, water injection

Wet power rating is 26,500 lb. thrust, sfc is 2.20

tachment. These four stages of loose pin-jointed compressor blades give the JT4 a distinct clattering noise as the engine is shut down.

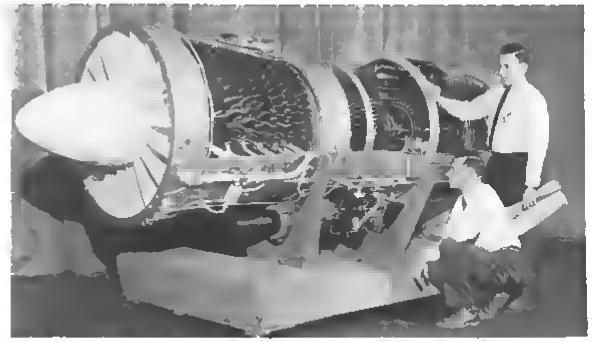
Airlines are being given a choice of two engines in each of the four thrust ratings in the JT4 family. One of the engines in each class is made primarily of steel, the other uses more titanium. The steel engine is heavier, but its initial cost is lower.

The JT4A-3, the first production engine, weighs 5,020 lb., and the only titanium used in it is in the first four low compressor stages. The titanium engine—the JT4A-5—being offered with this same thrust rating uses titanium throughout the low-pressure rotor for blades and disks and in the first three high-pressure compressor stages. This engine weighs 4,815 lb.

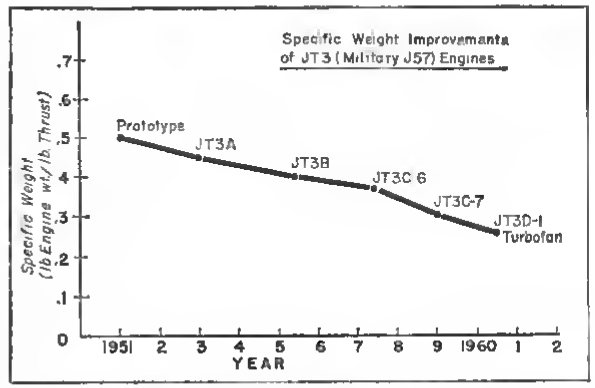
Military services save even more weight by using a titanium case for the low-pressure rotor on their J75s.

The two forward fan versions of the JT4 follow the general plan for building bypass turbojets that Pratt & Whitney has followed. Bypass air is taken in at the very front of these engines and passed through two or three rotating compressor stages. The air is then exhausted well forward on the nacelle and travels aft to mix with the higher velocity gas stream exiting from the main part of the engine. Pratt & Whitney tests have shown that this method of exhausting the bypass air does not increase nacelle drag and that the propulsive efficiency of the engine is increased as much as if the bypass and main air were mixed internally.

The very long compressor blades required by this type of fan engine are primarily the result of Pratt & Whitney's development of J91 nuclear turbojet. These very long blades are supported by a shroud located at approximately the mid-point of their span.



CUTAWAY MODEL of the JT4 is used for demonstration and instruction.



PRATT & WHITNEY philosophy of engine development is illustrated here. The company first designs conservative experimental engines which will run for long periods. The mass of data thus obtained is used continuously to lighten and improve the design.

Sikorsky Envisions Supersonic Airliner

Stratford, Conn.—Razor-edge thin airfoils or wedge-shaped airfoils may be only the second best way to fly efficiently over the entire speed range from conventional takeoff and landing through Mach 2-3 as in the case of a supersonic transport, a report by Sikorsky Aircraft engineers suggests.

A supersonic transport conceived by Michael F. Gluhareff, Sikorsky engineering manager, illustrates this approach.

- **Wing** is moderately thick, about 6% in relation to chord. Because of the long chord, however, this makes for a thick wing in practical fact and advantage is taken of this for fuel storage.
- **Leading edge** is convex, designed for elliptical lift distribution.
- **Aspect ratio** is 1.27 which is held to be superior to the required highly swept delta range of 1 to 1.3 in stability characteristics at all speeds and relatively unsusceptible to drag rise in the transonic region.
- **Rounded leading edge** provides for maximum heat dissipation and provides high lift coefficients at low speeds.

Although not indicated on the three-view, the vertical fin would probably be redesigned so that its maximum area would be on the underside of the wing, not on top. Because delta wings at low speeds produce lift due to immense tip vortices the aircraft would be considerably more stable with the fin removed from the area of the vortex.

The design is based on the use of four advanced version Pratt & Whitney J58-C turbojets in the 30,000 lb. thrust class and capable of delivering high thrust at Mach 2.5 at altitudes on the order of 50,000 ft. Gross weight is approximately 300,000 lb.—about the same as the long range Douglas DC-8 or the Boeing 707-320 and the payload of 40,000 lb. is in the same general class with these aircraft.

Range is computed at 3,600 mi. with reserves at Mach 2.3, based on a fuel weight of 150,000 lb. and a structural weight of 110,000 lb.

Sikorsky, at least at the moment, has an intention to build such a transport. However, the design has been shown to Pan American World Airways. Sikorsky would like to see these ideas developed by others, particularly a high trimmed-lift device which Sikorsky is wind tunnel testing.

One direction these studies may be taking is indicated by a design for an advanced high speed single rotor single blade vehicle Sikorsky showed in an exhibit to United Aircraft Corp. stockholders at the annual meeting. This vehicle, designated the S-57, uses the same convex wing planform with the fin mounted on the underside. The transport concept which envisages a form of double-bubble construction for its two-level passenger pressure cabin, has a number of other design features.

- **Fuselage** follows the area rule, utilizing the natural taper of the fuselage in relation to the aft placement of the delta wing to obtain the proper cross sectional area.
- **Retractable canard** surfaces are used with the leading edge high lift device for high trimmed lift coefficient at low speeds.
- **Retractable fins** on the wing underside are raised at high speed, extend at low speeds for roll damping. Due to the high sweepback the planform itself shows practically neutral stability without any flow at low lift coefficients as would be found at high speeds.
- **Elevons are outboard** of the wing semispan for minimum low speed control interference. The control surfaces are hinged along a line perpendicular to the wing vortices rather than arbitrarily perpendicular to the wing chord.

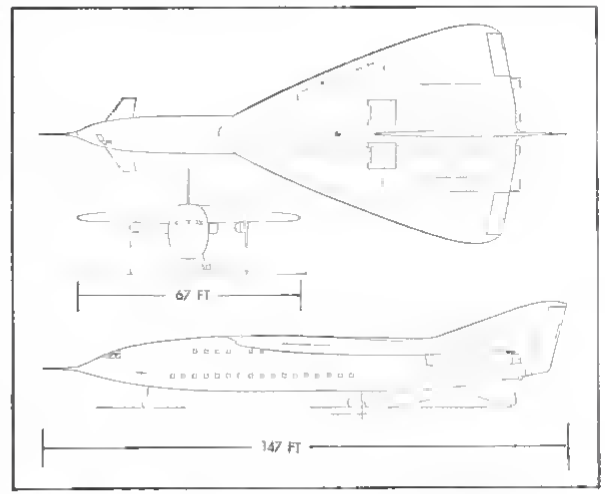
The Sikorsky report on the convex wing, as referred to in some variations as the heart wing or planform wing, questions half a dozen assumptions on delta wings. One is that the delta must have the planform on an equilateral triangle with 60 deg. sweep and an arbitrary aspect ratio of 2.31 with relatively low pitching stability at low lift coefficients. Another is that the delta should have the same thickness and leading edge configuration that straight wings have and that the section is constant with span.

The report emphasized that the flow on a delta is primarily three dimensional not two and that aspect ratio is critical throughout the speed range from 100 to 2,050 mph. At low speeds and high angles of attack the immense tip vortices sweep the whole upper surface of the wing. Strength of these is described as so great that the airflow over the entire wing, not just in boundary layer but in depth, follows the path of the vortex flow, energizing the velocities over the top portion of the wing. These vortices must be properly spaced for maximum effect as well as lift/drag considerations, thus the emphasis on the 1.27 aspect ratio.

At high speeds three dimensional flow is not easily visualized, but it is known that as long as the leading edge is far enough behind the shockwave subsonic flow might be generated and thus aspect ratio is determined up to Mach 2.5 by this required sweep of the leading edge.

Though it would seem different aspect ratios would be needed to best meet conditions at each end of the speed scale, the report said that in the 1 to 1.3 range the optimum is reached at 1.27, which is also the aspect ratio of a circular disk.

In the low speed range a maximum



SIKORSKY DESIGN for a supersonic transport has a moderately thick wing with a convex leading edge. Design includes retractable fins on the wing underside.

lift coefficient is found here as well as a stable pitching moment curve with no reversals with angle of attack. Stall is very gradual. Furthermore, the report says, the slope of the lift curve at low angles has a characteristic dip which would allow for high speed flight in rough air. This is because the change of lift coefficient with angle of attack is considerably less than for a higher aspect ratio wing.

Based on tests by the National Aeronautics and Space Administration and the Royal Aircraft Establishment, the report noted that:

- **Induced drag** (drag due to lift) can be reduced — at low lift coefficients around 0.2 as much as 50%—in a wing designed for constant coefficient of lift as against a twisted wing having a straight leading edge.
- **Wave drag** at Mach 1 is approximately 25% less than the equivalent delta with a straight leading edge.
- **Adding area rule** to these transonic drag rise is reduced to a small amount.

Lower Drag

The Sikorsky report adds further that comparing a 1.27 aspect ratio delta wing with subsonic airfoil against a delta with 60 deg. sweep and wedge airfoil, the subsonic wing has 50% lower drag, its lift/drag ratio is 30-40% better and the pitching moment is on the order of 5% of the pitching moment of the higher aspect ratio delta. Thus the drag or power required for trim for level flight for the low aspect ratio wing is negligible up to Mach 2.+

These figures are called conservative, since the report contends that wing drag of a properly designed low aspect ratio delta is perhaps half that of a straight wing of the same area. Thus, it says, a subsonic airfoil may be made to operate more efficiently at supersonic speeds than a supersonic airfoil.

The report suggests that further improvement might be possible. Since the low aspect ratio delta has a very rapid reduction of chord with span, an inverse thickness ratio—decreasing the percentage thickness of the root chord in comparison with tip chord percentage thicknesses—might add benefits.

Landing Speeds

Tests of models with a convex delta and using the special high lift device have indicated sufficient stability and lift generation to make possible landing speeds of perhaps 100 kt. for the supersonic transport design. This might eliminate one potential problem of the supersonic transport in that today's airports could not cope with it.

Gluhareff is the designer of the Sikorsky flying boats that began transocean service in the 1930s—the S-40, S-42 and S-44.

SAAB S29C photo-reconnaissance aircraft flies over rugged mountains north of Arctic Circle near Norwegian border of Sweden.

Swedish Air Defense, Part II

Sweden Tests Cold Weather Operation at Northern Base

By David A Anderton

Air Base F21, Sweden—This sub-Arctic base is a strong bastion, designed to defend northern Sweden and unintentionally protecting NATO's northern flank.

Its geographic position near Lulea makes it the natural center for a complex of military bases aimed at stopping air or ground drives against the rich natural resources and heavy industries of northern Sweden.

Although not a NATO country, neutral Sweden stands geographically in the way of any Russian drive against the northern NATO countries of Denmark and Norway. The only way there is, is through or over Sweden, and the Swedes have served notice that they know it and that they would fight. The fight would start from here.

F21 is both a unit and an air base designation. It is headquarters for Eskader 4 (4th Group) which includes the 21st Air Base Wing (Kungl Norrbottens Flygbaskar), 11th Reconnaissance Wing, and 4th and 15th Day Fighter Wing. Base commander at F21, Col B Bellander, is also deputy chief of Eskader 4.

As the farthest-north permanent base in Sweden, F21 is a center of winter cold-weather operational experience. This experience is passed along to the other units of the Royal Swedish Air Force in two ways.

- By the winter test establishment, which puts new aircraft and equipment through their technical and operational paces in cold weather and feeds this information back to designers, pilots and ground crews.
- By stationing other squadrons here on temporary duty for a month at a time during the year to absorb a refresher course in Arctic operations.

As a winter base, F21 is typical of the North. From October through May, heavy snowfalls blanket the area with two or three feet of snow per storm. Continuous snow-clearing is the rule, and plows and blowers work around the clock.

Long Arctic Night

F21 has other advantages that make it an unusual operational training station. During the "long night" of the Arctic winters, the sun rises sometime around 11 a.m. and sets sometime after 2 p.m. The rest of the day is dark, and squadrons go on night-flying missions during what would otherwise be daylight hours. This is one of the few bases where a pilot can get up at a respectable hour in the morning, have a leisurely breakfast and then complete a night flying exercise before lunch.

Lulea stands on sandy soil at the top of the Bothnian Gulf between Sweden and Finland, and the winds roar up the gulf carrying bad weather. At one time they carried along a complete sandstorm, and F21 is the farthest-north and only RSAF base to have suffered through one of the hazards of equatorial desert operations (AW Mar 9 p 307).

Work of the winter test unit is phased in early in the development program of any new airplane or piece of equipment. Preproduction planes fresh from early positions on the line at Saab Aircraft Co are flown north for their first baptism of the snow in which they will spend a large part of their useful life.

Here the planes are flown hard by experienced test pilots in what would correspond to operational suitability trials in the USAF. Planes are flown in the patterns of operational sorties, on standard mission profiles to determine their toughness in a wintertime of simulated wartime.

Weapons are fired, communications and navigation gear checked, equipment inspected for any of the flaws that could cause trouble in cold-weather operations. Planes are cold-soaked, left out in the line in sub-zero weather, and then fired up and flown. A few weeks of this quickly shows whether or not the plane will ever take the rigors of the frozen north.

This program continues through the useful life of the airplane. At the time of AVIATION WEEK's visit, the latest modification of the Saab Draken—area-ruled and with a whacking big afterburner—was going through another routine series of checks. It has been through the Arctic mill before in prototype form, but carries as many as six different camera installations and has modernized avionic equipment for better navigation.

It is a subsonic airplane, in fact the first sweptwing fighter to go into production in Europe, so it's getting a little old for the job. Its replacement is the Saab S32C, a photo-reconnaissance modification of the A32 Lansen attack aircraft, now being delivered to the Royal Swedish Air Force.

Normal camera installations include a pair of vertical mapping cameras, a pair of oblique survey cameras mounted one on each side, and a pair of low-altitude cameras, with 30-in. and 36-in. lenses for ground-hugging work.

During our visit, two pilot officers were briefed on a routine photo-reconnaissance mission to demonstrate the type of work done and their effectiveness in doing it. Briefings were in English.

The weather was not kind. A secondary cold front was moving eastward at about 32 kt., carrying snow showers with it. Low altitude wind was northwest and strong and there was a heavy turbulence below 3,280 ft. Upper altitude winds were southwest, with jet stream speeds up to 80 kt. Contrails began at 26,200 ft. Weather at F21 was clouds with 1,970 ft. base, visibility 1.9 to 3.1 mi.

One set of runway lights was not operational, but otherwise the standard radio and navigation aids were in order. This was the environment.

First mission was a single plane low level photography job on a reported

ROYAL SWEDISH AIR FORCE S29Cs are between missions at Air Base F21, headquarters for RSAF winter test establishment.

PHOTO-RECONNAISSANCE is performed by Saab S29C Flying Barrels, a modification of RSAF standard operational interceptor. Technicians pull film rolls from cameras after plane returns from mission (left). Low-level camera has telephoto lens, shoots forward and downward at a slight angle. Section of inlet cowl forward of camera (right) retracts for photography, is normally flush during mission.

FILM is taken from cassettes in portable darkroom on flight line, packed in containers, and delivered to the photo laboratory by motorcycle courier. Note ski-skid arrangement on motorcycle for winter operations on ice and snow-covered roads

"enemy" radar station, actually one of the Swedish radio transmitters in a tough location to spot. The pilot was told to make his run in as low as possible, to go over the target at low altitude and return over a check point identified by grid coordinates. Takeoff time was 1000 hr., estimated time of arrival was 1045 hr. His aircraft was Red Charlie, and the briefing officer reverting to the old phonetic alphabet, and cameras were to be fitted for low altitude.

The second pilot was asked to determine if there were "enemy" aircraft at a grid point and if so what type. The target in reality was one of the satellite bases of F21. The run in was to be at minimum altitude to a check point, followed by an accelerated fast climb over the target. Photos were to be taken with vertical cameras.

Alternate Mission

If the weather was impossible and the pilot could not make a high-level run, he was to make a low-altitude dash and use his nose cameras. Altitude choice depended on the weather. The return flight was to be over a check point and at minimum altitude. Take-off and landing times were the same as for the first mission, and the aircraft was Red Bravo.

Both planes scrambled together on time and we waited for their arrival. Estimated times of arrival were good, and both planes were in the pattern on time. They had hardly stopped taxiing before the ground crews were unbuttoning the camera hatches and hauling out the film cassettes. Planes were met by a mobile dark room where a technician transferred the exposed film to special containers, and where he would reload

PILOT completes shutdown while rolls of film are being removed after mission

the cassettes during maximum effort missions.

The containers were taken by motorcycle from the line to the photo laboratories and the pilots went for debriefing.

New from Honeywell:
a high-performance miniature gyro with input freedom of ±60 degrees

Advanced design of the Wide-Angle MIG allows you to program missile flight while cutting size and weight of missile guidance system by more than 50 per cent.

HONEYWELL's leadership in gyro design is proved again. The new Wide-Angle MIG is a miniature integrating gyro with such a wide range of input angular freedom that it can be moved about its input axis up to ± 60 degrees without loss of space orientation.

At the same time this new gyro retains all the accuracy and extremely high performance characteristics of Honeywell's famous MIG family.

A floated gyro, the Wide-Angle MIG employs a damping technique that represents a distinct advance in the state of the art. It's the perfection of this technique that makes possible a gyro combining great input freedom with high accuracy.

Honeywell's Wide-Angle MIG offers advantages across many applications.

It is the most accurate miniature floated gyro available for radar systems that warn of distant ballistic missiles. Locked into the radar, it is capable of measuring a rate of movement as low as 10^{-6} radians per second—far superior to the rate gyros which are normally used in such applications.

In fact, the new gyro provides unusual benefits in any application that requires small size and weight, high accuracy and great input freedom. It is designed for both analog and digital rebalance systems and has other features which include increased torquing rates (to 80,000° per hour) and tolerance of ambient temperatures to 500°.

For complete information on Honeywell's new Wide-Angle Miniature Integrating Gyros, call or write Honeywell Aero, 2600 Ridgway Road, Minneapolis 13, Minnesota.

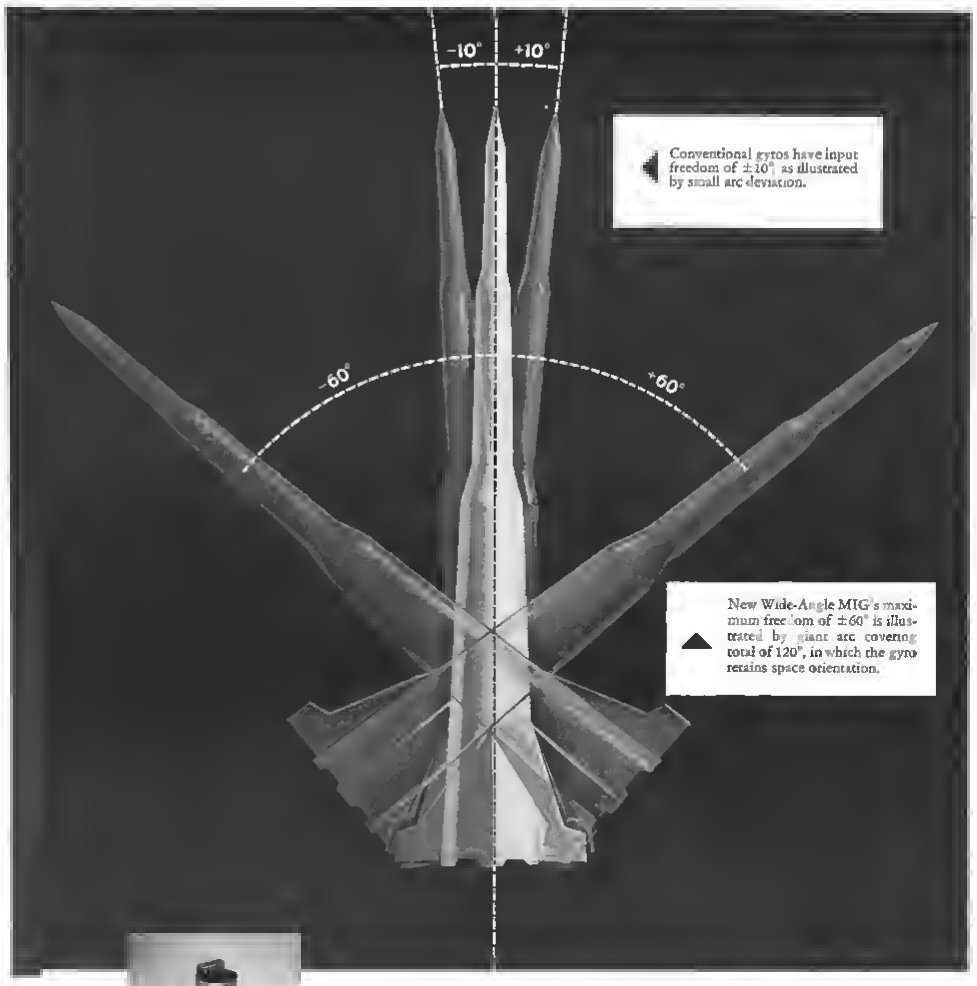
WIDE-ANGLE MIGS BY HONEYWELL

GG107 gyro for digital systems

GG30 gyro offers 80° input freedom

GG87 gyro has extremely low drift rate (exact rate classified)

GG83 gyro operates in ambient temperatures of 500°F.



Wide-Angle MIG illustrated occupies less than eight cubic inches, weighs less than one pound. It's part of Honeywell's complete line of 24 floated and two-axis gyros for all high-performance aircraft and missile requirements.

Honeywell

Military Products Group

JATO Boosts C-130B in Propeller Stress Test

Lockheed C-130B takes off assisted by eight JATO bottles during propeller stress tests at Eglin AFB, Fla Gross weight is 135,000 lb —almost maximum Ground run was 2,300 ft from point of engine runup. C-130B made first flight in December (AW Dec. 22, p. 63)

and a well-deserved sauna There had been plenty of turbulence and they were tired from flying on the deck through continually rough air.

Mission Results

Both strikes were successful Within one hour after the planes returned we were looking at yards of wet negatives and seeing the tiny mast of the "radar" station almost lost among towering trees but dead center on the frame On the large rolls from the vertical cameras we could see the runway, taxiways and dispersal points where "enemy" interceptors stood at the satellite base

"There were two things wrong," said the briefing squadron leader "First, they used too much film—because they wanted to make sure of their target—and second, we should have had these negatives within 30 minutes."

(A concluding article on Swedish air defense will appear in next week's Aviation Week *)*

PRODUCTION BRIEFING

Fairchild Camera and Instrument Corp, Syosset, N Y, will produce two types of aerial reconnaissance cameras under Air Materiel Command contracts totaling $4,042,303 Cameras are the CAX-12, 70 mm precision day reconnaissance camera and the K-47 night reconnaissance camera which uses flash bomb for illumination

American Machine & Foundry Co, Engineering Division, Greenwich, Conn, will develop the ground installation of the guidance antenna for the Titan ICBM under $3 83 million contract from Bell Telephone Laboratories AMF will design the hardened antenna storage and elevating equipment for the guidance system

ACF Industries, Inc., American Car and Foundry Division, Berwick, Pa, will continue production of Snark missile launchers under $2.25 million follow-on contract from the Northrop Corp The 16-wheeled launcher carries and erects the missile.

C Itoh & Co, Ltd, Tokyo, will represent Ryan Aeronautical Co in promoting sales of Firebee jet target drones in Japan. One year agreement gives Itoh rights to solicit sales, while Ryan reserves the right of acceptance or rejection

Air Cruisers, Bel Mar, N J, division of The Garrett Corp, will deliver 126 25-man life rafts to Trans World Airlines for use on overwater flights of the airline's jet aircraft

Greer Hydraulics, Inc, Jamaica, N Y, will distribute the Air Partner jet starting equipment in the United States under license from Atlas Copco A B, Stockholm, Sweden Air Partner is a rotary screw type air compressor suitable for jet starting, air conditioning and de-icing

General Acoustics Corp. of Los Angeles Corp has been formed to design and develop aircraft, missile and industrial noise suppression products

Army Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U S Army contracting offices

U S ARMY ORDNANCE DISTRICT, Philadelphia 120 North Broad Street Philadelphia 2, Pa

Brown Instrument Division Minneapolis Honeywell Regulator Co., Philadelphia Pa modification of government owned Brown Instrument Electronic Strip Chart Recorders DA-36 034 ORD 2669 $36 076

Aircraft Armaments Inc., Cockeysville, Md., thruster cartridge actuated T-25 DA-36-034-ORD-2850 $52 126

Western Electric Corp. New York Nike spare parts and components DA-36-034-ORD-2228 $1 22 200 Nike spare parts and components, DA-36-034-ORD 2228 $69 200

General Electric Co. Philadelphia Pa, production of films in connection with Phase II, Little John rocket program, DA-36-034-ORD-2635, $82 286

Telex Instrument Division, Bendix Aviation Corp., Towson Baltimore Md., design development and fabrication of a preset baroswitch project TN2-3129 DA-36-034-ORD 2650-RD $65 741

Western Electric Co, New York Nike spare parts and components DA-36-034-ORD-2228 $31 622, Nike spare parts and components DA-36-034-ORD-2228 $48 500

Remington Rand Univac Division Sperry-Rand Corp Philadelphia Pa design study of an electrical digital computer DA-36-034-ORD-2672 RD $55 527

North Carolina State College of Agriculture of the University of North Carolina, Raleigh N C., study of motion of spin-stabilized rockets during burning determination of launch parameters and development of instrumentation for the determination of experimental data and to simplify analysis of this data DA-01-021 ORD-4592 and DA-36-034-505 ORD 35-RD, $13,500

Western Electric Co, Inc., New York Nike spare parts and components DA-36-034 ORD-2228, $45 120 Nike spare parts and components, DA-36 034-ORD-2228 $147 604, Nike spare parts and components, DA-36 034-ORD 2228 $44 240, Nike spare parts and components DA-36-034-ORD-2228 $126 876

Western Electric Co., Inc, New York Nike spare parts and components DA-36-034-ORD-2368 $14 516 Nike spare parts and components, DA-36-034-ORD-2368 $41,287, Nike spare parts and components, DA-36-034-ORD-2368 $46 802

Electron Tube Division, Radio Corporation of America Lancaster Pa study of Solid State Image Intensifier for Industrial Application DA-36-034 ORD 2676 $24 000

Western Electric Co., Inc New York the following contracts are for Nike spare parts and components and appear under contract number DA 36-034-ORD-2228 $171 780, $662 220, $159 151, $101 270, $104 340 $179 220 $160 200

Western Electric Co Inc. New York. Nike spare parts and components DA 36-034 ORD 2228 $328 529

Western Electric Co Inc, New York Nike spare parts and components DA 36-034 ORD 2228, $100 023 and Nike spare parts and components DA-36-034-ORD-2228, $28 577

Western Electric Co Inc., New York Nike spare parts and components DA 36-034 $78 406 (4) $124 148

Douglas Aircraft Co, Inc, Santa Monica Calif Bine Streak and emergency spare parts, $138 433 and Bine Streak and emergency spare parts DA-36-034 ORD-2582, $116 354

U S ARMY ENGINEER DISTRICT, Omaha, Corps of Engineers 1702 Jackson Street Omaha, Neb

Olson Construction Co. Lincoln Neb construction of shop A/C engine inspection and repair Lincoln AFB Neb. Contract No DA-25-068-ENG 5515(IFB ENG-25-066 59 54) $263 996

Peter Kiewit Sons Co Omaha Neb construction of extension of road Offutt AFB Neb, Contract No DA-25-066-ENG-5515(IFB ENG-25-066-59-41), $200 976,

Kingery Construction Co., Lincoln Neb construction of readiness crew building Lincoln AFB, Neb Contract No DA-25 020 ENG-5513(IFB ENG-25-066-59-32), $617 744

Gunnar I Johnson & Son Co Minneapolis, Minn. construction of dormitories shop and fuel storage, Grand Forks AFB N D. Contract No DA-25 066-ENG-5514(IFB ENG-25-066-59 77), $257 922

Gregory Brothers St Cloud Minn., construction of aleri apron blast pavement, perimeter facilities and bridge, Grand Forks AFB, N Dak Contract No DA-25-066-ENG-5514(IFB ENG-25-066-59-70), $376,966

BOSTON ORDNANCE DISTRICT, Army Base Boston 10 Mass

Avco Manufacturing Corp, Everett, Mass research in re-entry physics Contract No DA-19-020-ORD-4862 $684 000

Raytheon Manufacturing Co., Andover, Mass electronic components Hawk missile Contract No DA-19-020-ORD-4777, 18 line items $82,280.

Raytheon Manufacturing Co., Andover, Mass electronic components Hawk missile Contract No DA-19-020-ORD-4777 6 line items, $30,336

U S ARMY ENGINEER DISTRICT, Pittsburgh, 323 New Federal Building, Pittsburgh Pa

Mahon Construction Corp., New York construction of missile master facilities phase I and II Pittsburgh Defense Area Collier Township, Allegheny County Pa. IFE ENG-36-055-59-26 $7,716 237

U S ARMY ORDNANCE DISTRICT, Los Angeles, 22 South Grand Avenue, Pasadena, Calif

Firestone Tire & Rubber Co, Los Angeles guided missile artillery $6 044 050

North American Aviation, Inc, Canoga

Park, Calif., rocket engines, $3,643,880

Motorola, Inc, Phoenix, Ariz., telemetry sets, $101,597

Solar Aircraft Co, San Diego, Calif., study, $187,000

Douglas Aircraft Co., Inc., Santa Monica, Calif., supplies and services, $40,000

Douglas Aircraft Co., Inc., launching area items, $890,000 and repair parts, $397,500

Missile Development Division North American Aviation, Inc., Downey, Calif., study of hypervelocity impact, $47,972

North American Aviation, Inc., Canoga Park, Calif., design and development, $180,000,000

North American Aviation, Inc., Canoga Park, Calif., rocket engines, $112,505

Missile Air Division United States Chemical Milling, Manhattan Beach, Calif., bulkheads, $44,408

Firestone Tire & Rubber Co., Los Angeles, Calif., repair parts, $91,650

Gilfillan Bros., Inc., Los Angeles, Calif., repair parts, (1) $88,517; (2) $31,128; (3) $78,496; (4) $124,146.

Firestone Tire & Rubber Co., Los Angeles, Calif., spare parts, $52,068

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U.S. Air Force contracting offices:

HEADQUARTERS AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, AIR RESEARCH AND DEVELOPMENT COMMAND, Washington 25, D.C.

Baylor University, Houston, Texas, continuation of research on Investigation of the Effect and the Mode of Action of the Psycho-Chemicals on Human State of Consciousness," (AF18(603)-72), $58,074

Massachusetts Institute of Technology, Cambridge, Mass., continuation of research on "Neutron Diffraction Studies of Solids," (AF18(603)-84), $91,950

New York University, New York, continuation of research on "Ignition and Combustion of Organo-Metallic Compounds," (AF49(638)-173), $75,000

Carnegie Institute of Technology, Pittsburgh, Pa., continuation of research on Conformal and Variational Methods, (AF49(638)-272), $24,958

Washington University, St. Louis, Mo., continuation of research on "Paramagnetic Resonance of Free Radicals," (AF18(638)-464), $75,000

Republic Aviation Corp., Farmingdale, L.I., N.Y., research on Electromagnetically Induced Chemical Reaction, (AF49(638)-552), $63,882

The Regents of the University of Minnesota, Minneapolis, Minn., research on Theoretical and Experimental Studies of Mass Transfer for Cooling," (AF49(638)-558), $118,894

President and Fellows of Harvard University, Cambridge, Mass., Theoretical Studies of the Interactions of Fields and Particals," (AF49(638)-566), $74,795

Texas A & M Research Foundation, College Station, Texas, study of Electronic Absorption Spectra of Simple Molecules," (AF49(638)-567), $38,878

University of Maryland, College Park, Md., continuation of Theoretical Research Program in Statistical Mechanics and Chemical Physics," (AF18(600)-1315), $107,169

The Pennsylvania State University, Park, Pa., continuation of research on "The Crystal Structural Bases for Some Physical Properties of Crystalline Salts," (AF18(603)-35), $114,965

The Catholic University of America, Washington, D.C., continuation of research on Irreversible Thermodynamics," (AF49(638)-452), $37,681

Plasmadyne Corp., Santa Ana, Calif., continuation of research on "Acceleration and Channeling of Continuous Plasma Jets by Magnetic Fields," (AF49(638)-336), $82,334

The Pennsylvania State University, University Park, Pa., "Field Emission Studies of Metal Surfaces, (AF49(638)-154), $77,641

Soviet Tu-114 turboprop transport, shown at Moscow Airport, can fly nonstop from Moscow to New York with 120 passengers.

Tu-114 Turboprop, Bear Bomber Compared

Larger Tu-114D, civil version of the Tu-95 Bear turboprop bomber, has thinner fuselage than Tu-114. Aircraft is powered by four Kuznetsov NK-12 engines (AW Oct. 6, p. 36), producing 12,000 eshp. each. Sweep of wing is apparent in photo below.

Flight view of Tu-114D emphasizes sweep-back of wing, which appears to be set higher than that of Tu-114. Note radome on nose.

Bear bomber (above, over Tushino) has range of about 8,000 mi. Wing aspect ratio is between that of Boeing B-47 and the B-52. Tu-114 civil version (right) is double-decked. Engines apparently have higher compression ratio than usual Russian turbine engines, probably good fuel consumption compared with Western turboprops.

Bear bomber (below) has a tail similar to the Bison and Badger. Bulges near the tail gun compartment are radomes, similar installations are on all Russian bombers. Wing is quite stiff, compared with Western planes. Skin does not wrinkle as much as U.S. planes, indicating use of a heavy skin.

Nuclear Rockets May Operate by 1970

By Michael Yaffee

New York—Nuclear-powered rockets are almost certain to be flying major space missions by 1970, scientists working in the field believe. High specific impulse and sustained power capability gave them a strong competitive edge on their chemical counterparts and, despite several important problems such as materials limitations that still have to be solved, assure them a significant role in future space exploration.

Consensus among a rapidly growing group of reputable scientists is that the first type of nuclear propulsion unit to see extensive service will be a comparatively unsophisticated low power heat transfer rocket in which the working fluid or propellant and the energy source are distinct.

In its simplest form this rocket will use a solid core fission reactor to heat a working fluid which will then be ejected through an expansion nozzle to produce thrust. Very likely it will be boosted off the launch pad by a large chemical rocket.

Early Stage

Actual United States nuclear rocket program, Project Rover, is still in an early development stage (AW Feb. 16, p. 48). Nevertheless, established propulsion scientists and engineers are now expressing unreserved confidence in the development and performance of nuclear rocket propulsion and, in technical society papers and official presentations before congressional committees, show a somewhat surprising amount of agreement in the pictures they draw of tomorrow's nuclear-powered space vehicles. Here, briefly, is how they collectively see the first nuclear rocket in design, operation and function.

For power it will use an open cycle solid fuel core, fission reactor. Of all possible ways of using nuclear energy for rocket propulsion, this approach is presently the most advanced owing largely to the knowledge and experience gained from work on stationary atomic powerplants. Other methods—electromagnetic acceleration, radioactive isotope decay, fusion—are still in a comparatively early research stage and are not expected to find applications until somewhat later despite recent major advances in the direct conversion of nuclear energy to electricity.

The reactor will be located in what would correspond to the combustion chamber of a chemical rocket. Core of the reactor will consist of fuel elements, control rods, moderators and reflectors. The core will be enclosed in a cylindrical pressure shell which will be attached to a regeneratively cooled De Laval rocket nozzle.

Fuel elements will be flat or slightly curved plates of uranium-235 and a non-fissionable, high-temperature structural material. Choice of the structural envelope for the uranium is still open to question. In a paper prepared for presentation before the House Committee on Science and Astronautics, W. J. Rombardt, J. J. Newgard and Myron Levov of Thiokol's Reaction Motors Division suggest graphite as a combination moderator and matrix for the uranium.

Frank Rom and Paul Johnson of the National Aeronautics and Space Administration's Lewis Research Center chose tungsten in their study of a space nuclear rocket engine which they described at the recent Society of Automotive Engineers National Aeronautics Meeting. Because natural tungsten competes with uranium for the neutrons generated in the reactor, Rom and Johnson propose to separate out and use only the tungsten-184 isotope which has a comparatively low neutron capture cross section.

As a moderator, Rom and Johnson favor the use of hot-pressed blocks of beryllium oxide. These units, whose sole purpose is to slow down fast neutrons, would be inserted between the fuel element plates. The reflector surrounding the fuel elements will be fabricated from beryllium or beryllium oxide.

Boron, which has a fairly high melting point and neutron absorbing capacity, will be used to control the reactor. (Other materials, such as the

MARS MISSIONS

Mission	Required Velocity Increment (mi./sec.)	Rocket Propulsion System	Operating Temperature	Specific Impulse, sec.	Payload lb.	Time days
Minimum energy round trip (initial weight in orbit 25,000-lb. vehicle)	8.9	chemical		400	1,900	973
		fission	4,500°F	940	5,500	973
		fission	8,000°F	1,330	9,300	973
		electric		5,000	10,200	1,099
Extra energy round trip (initial weight in orbit, 100,000-lb. vehicle)	9	chemical		400	0	
		fission	4,500°F	940	1,100	508
		fission	8,000°F	1,330	7,400	508
		electric		5,000	27,600	803
Extra energy round trip, 30-day wait at Mars (initial weight in orbit, 500,000-lb. vehicle)	14	chemical		400	0	
		fission	4,500°F	940	7,500	570
		fission	8,000°F	1,330	49,000	570
		electric		5,000	0	

Table, prepared by NASA's Frank Rom and Paul Johnson, compares performance of three propulsion systems on three different round trip Mars' missions. Vehicles start from a 300-mi. altitude earth orbit, swing or orbit around Mars and then return to an earth orbit.

rare earth metal gadolinium which has 50 times the neutron absorbing capacity of boron, show promise but are expensive and still in a comparatively early stage of development.) Actual control will be effected by insertion of the boron into the core and close to the fissioning fuel elements.

Rom and Johnson suggest the use of control rods which can be inserted uniformly in the moderator regions. Small solar-powered electric motors, located on a bulkhead in the pressure vessel would drive the rods in and out. Reinhardt, Newgard and Levov feel reflector control would prove more efficient, easier to use and cool, less likely to cause channel blockage, and would leave more room for fuel elements.

Curved stainless steel control plates containing boron would be dropped into curved slots machined out of the beryllium oxide reflector blocks. Passing through a series of blocks, each control plate would ride in a bearing race in the bottom block and would be rotated by a mechanical drive system. To slow the reactor down, the boron-faced plates will be turned in toward the reactor core, absorbing neutrons and preventing them from bouncing off the beryllium oxide reflector. Turning the plate out will permit more neutrons to hit the reflector, bounce back into the core—at a slower speed—and find an atom of uranium-235.

Hydrogen Coolant

Hydrogen's low molecular weight makes it the almost inevitable choice for working fluid and coolant, despite its extremely low boiling point and high combustibility. Stored as a liquid in an insulated tank and under pressure, hydrogen will be fed by a turbopump into the end of the rocket nozzle. Here it will reverse its direction and flow forward through the walls of the nozzle and through passages in the reflector, where it will remove heat generated by neutrons and gamma radiation, and then into the plenum at the forward end of the reactor. At the plenum some hydrogen will be diverted for further cooling of reactor components and for driving the turbopump. Exhaust from the turbine will be ejected through small thrust recovery nozzles.

Most of the hydrogen, however, passes from the plenum into the reactor over the fuel elements where it picks up heat and out the expansion nozzle. To keep reactor weight low and at the same time include as much moderator material as possible, Rom and Johnson propose to make the total flow passage volume small, and suggest a flow area equal to 10% of the reactor core frontal area.

Though relatively simple, a core design based on a constant void fraction (flow area/total area) will result in a

rapidly increasing pressure drop as the gas approaches the hot end of the reactor, particularly of void fraction, according to Reaction Motors Division's Reinhardt, Newgard and Levoy. A variable void fraction through the core (with the higher void fraction at the hot end) would reduce this pressure drop without much added fabrication difficulty. Also, they say, it might be possible to reduce the structural weight of the reactor core owing to lower coolant drag forces on the structures.

In a nuclear fission system such as the one described, it is estimated that the temperature of the gas as it leaves the De Laval nozzle will run 4,000 to 4,500F. Specific impulse of the system will probably be between 900 and 1,000F.

Most rocket engineers and scientists believe this system concept can be turned into a working reality within 10 years. It will take this long, many of them feel, to solve the important problems still blocking the way to a practical, lightweight, mobile reactor capable of powering a space vehicle. Among the most critical of these problems are the following:

• **Development and fabrication** of materials capable of withstanding 4,000-5,000F. Because specific impulse rises with temperature, even higher reactor temperatures are desired but not considered feasible. Highest melting point of any known material, a 4:1 mixture of tantalum carbide and hafnium carbide, is only about 6,900F. Preferably, these refractory materials should also be lightweight, but this too appears inconsonant.

• **Radiation resistance.** Scientists have already accomplished a great deal in the development of radiation resistant, high temperature hydraulic fluids, lubricants, electronic materials, sealants and so on but feel that much greater improvements are still required.

• **Reactor controls.** To prevent propellant waste the reactor will have to be brought up to operating power in a matter of seconds. Controls will have to be developed that can do this and do it safely.

• **Shielding.** Heavy radiation shielding will be required to protect critical vehicle components and payload. Weight of the shielding will severely penalize vehicle performance and payload unless ways can be found to reduce the required amount of shielding or the weight of the shielding material. Separation of the reactor chamber from the rest of the vehicle offers a limited hope of relief here, as does shadow shielding.

• **Fission fragments.** Destruction of fuel elements during power operation may result in the formation of small radioactive fragments which could find their way out of the reactor and into the exhaust jet, causing contamination of the test stand and the adjacent areas.

• **Reactivity changes.** Destruction of core elements would also change void and solid volumes in the reactor and probably cause severe changes in the reaction rate.

• **Component development.** In addition to the problem of developing a mobile, efficient fission reactor, there are a number of smaller but still difficult problems involved in the development of the other essential components such as turbopumps and valves. The turbopump, for example, will be required to handle a cryogenic fluid in a hot, radioactive environment. The bypass valves which are used to control the turbine will have to stand up and react instantaneously and positively in regulating the flow of a 1,500F gas. Turbopump and valve controls will have to be tied in precisely to reactor control.

Solutions to some of these problems are already being formulated as a result of the nuclear rocket program, Project Rover, now under way at Los Alamos Scientific Laboratory. The Atomic Energy Commission's Aircraft Nuclear Propulsion project which is encountering many of the same problems is also supplying some answers (AW April 6, p. 87).

Air Force sponsored programs on the development of high temperature,

radiation resistant materials are making notable progress Specific hardware such as turbopumps and propellant tanks are also under development It is sufficient to say, Rocketdyne's chief engineer Thomas Dixon recently reported to the House Committee on Science and Astronautics, that required components can be provided by the time useful reactors are available

The next questions—the two important ones that Congress is asking U. S. space scientists—are these When nuclear rocket propulsion systems do become available, how will they be used and are they worth the money it will cost to develop them?

Fission rocket engines can be used to boost large payloads off earth into orbit or to the moon, they can be used for interplanetary exploration, starting from an earth orbit, traveling to Mars and other planets and returning to earth Nuclear engines are definitely worth the development time and money, say the scientists, they can do jobs chemical rockets can't do or they can do the same jobs faster and cheaper (AW Mar. 23, p. 28)

The first application of nuclear rocket engines will probably be in the second stage of a two-stage space vehicle The nuclear-powered vehicle would be boosted into a 300-mi. altitude earth orbit by a large chemical rocket based on the 1,500,000 lb thrust engines now under development Among other things, this would eliminate the problem of radioactive contamination caused by earth takeoffs More important, it will keep reactor power requirements within the realm of anticipated capabilities Orbit launching will reduce the required thrust from an amount greater than the total vehicle take-off weight (needed for lift-off from the earth's surface) to a small fraction of the initial weight

Typical mission for such a vehicle might be what NASA's Rom and Johnson describe as a minimum energy round trip to Mars The nuclear-powered craft accelerates away from its 300-mi altitude earth orbit so that it coasts on an elliptic path tangent to both earth and Mars orbits under the gravitational influence of the sun After 259 days, the space vehicle arrives at Mars where it decelerates into a Martian orbit It waits here 455 days for Mars and earth to get back into a favorable position for a 259-day return trip to an earth orbit The total trip requires 973 days and a total velocity increment of 6.9 mi. per second

Mars Mission

Assuming that NASA's 1,500,000-lb thrust chemical rocket now under development will be capable of boosting 25,000 lb into a 300-mi altitude earth orbit, Rom and Johnson developed the following nuclear rocket concept for the 973-day round trip Mars mission Total weight of the nuclear-powered vehicle, if measured on earth, would be 23,000 lb The payload will weigh 5,500 lb., reactor, 1,900 lb., control rod mechanism, nozzle pressure shell, solar batteries and guidance system, 500 lb., structure, 500 lb., propellant and tanks, 16,600 lb.

The fission reactor will have a maximum fuel element temperature of 5,000F, a maximum moderator temperature of 4,000F Hydrogen flow rate

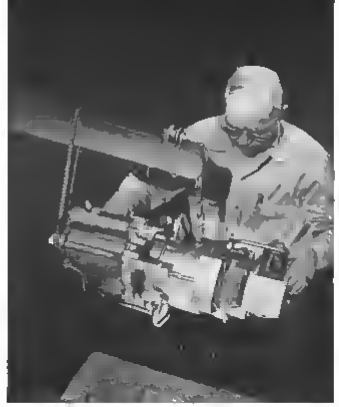
Camera Photographs Sputnik Track

Camera used for photographing track of the Soviet Sputnik satellite is shown in use at the astronomical observatory of the Latvian University in Riga

CAPABILITIES FOR DEFENSE

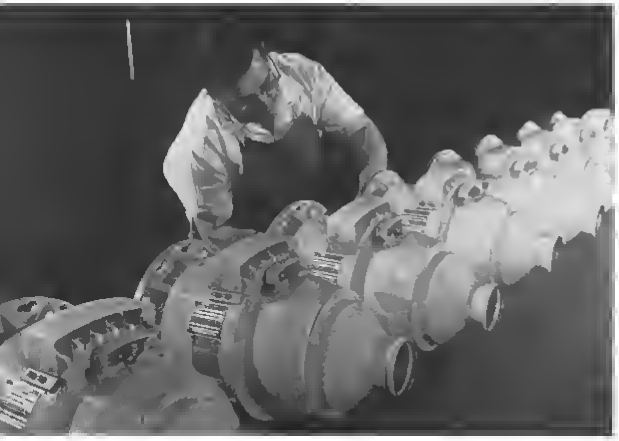
Westinghouse electrical systems, using first brushless generator, proved in thousands of flight hours

LONGER SERVICE LIFE and greater reliability result from the elimination of commutators, carbon brushes and collector rings, shown at right. A single internal rectifier bundle, held by girl, replaces them. High-temperature silicon diodes, produced by Westinghouse research in semiconductors, make this possible.

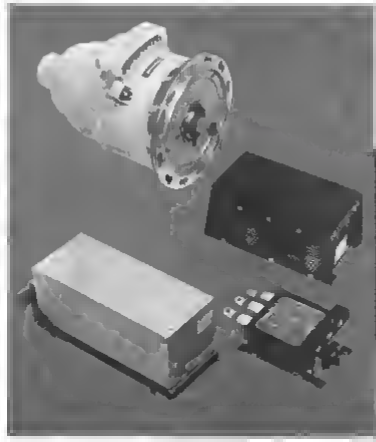


OIL-COOLED GENERATOR for Convair B-58 Hustler achieves major breakthrough of temperature barrier in electrical generator design—is cooled by MIL-L-7808 oil, having inlet temperature of 300° F. Usual generator troubles are eliminated—no brushes, commutating or slip-ring parts to wear. Results: greater economy, less frequent overhaul.

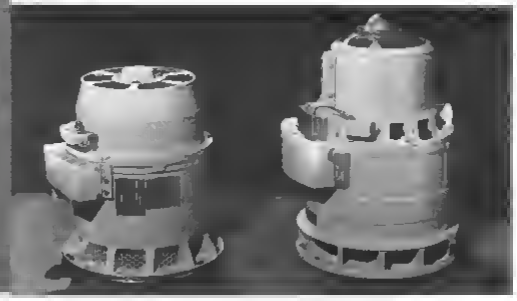
AUTOMATIC FUNCTION SIMULATOR, one of the newer testing techniques used by Westinghouse, assures more reliable protective devices for electrical systems. This machine subjects protective control panel to as many situations as it will encounter in flight operations.



NOW IN FULL-SCALE PRODUCTION. The world's first aircraft brushless generators have a key role in advanced electrical systems provided by Westinghouse for today's military and commercial aircraft. The 40 kva units above are standard in Boeing 707 jetliners. First introduced in 1954 by Westinghouse Aircraft Equipment Dept., Lima, Ohio, these dependable generators have performed thousands of flight hours on the Boeing 707 and the Air Force B-58.



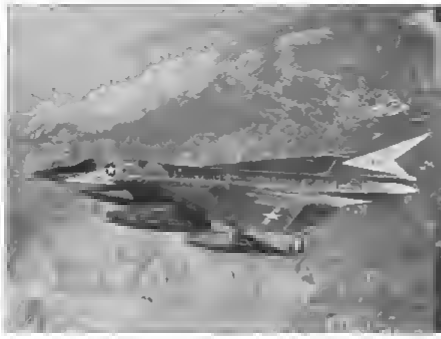
LEADER IN AIRCRAFT ELECTRICAL SYSTEMS. Westinghouse has been producing aircraft electrical systems since World War I—has built more a-c electrical systems for aircraft since World War II than any other company. Shown is the brushless air-cooled generator with control apparatus.



BRUSHLESS VERSUS BRUSH-TYPE GENERATOR. Both generators are 40 kva. The brushless generator on the left above uses less space and weighs less. Longer life is assured—air-cooled brushless generators are guaranteed for 3,000 flight hours, bearings up to 1,500 hours. Brushless generators with even greater life are under test at Westinghouse.

ROBOT CIRCUIT TESTER uses punched tape to check circuitry of control equipment with 100% accuracy, 60 times faster than previous techniques. Westinghouse automatic circuit-testing facilities speed production, eliminate chance of human error, improve product reliability.

NAVY—The North American A3J, completing flight tests preparatory to joining the fleet, uses the Westinghouse electrical system, including oil-cooled brushless generators.



AIR FORCE—The Convair B-58 Hustler employs the Westinghouse electric power system, including oil-cooled 40 kva brushless generators.

COMMERCIAL—The Boeing 707 uses Westinghouse electrical system, including air cooled brushless generators—proved in thousands of flight hours.

Westinghouse

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1000 CONNECTICUT AVENUE, N.W., WASHINGTON 6, D. C.

AIR ARM DIVISION
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ELECTRONICS DIVISION
AIRCRAFT EQUIPMENT DEPARTMENT
ORDNANCE DEPARTMENT

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will be .35 lb /sec The hydrogen will be ejected from the expansion nozzle at a temperature of 4,500F and with a velocity coefficient of 96 The nozzle will have stainless steel walls and an area ratio of 50-1 Specific impulse of the system will be 940 sec , thrust, 330 lb Power rating of the reactor will be 6 7 megawatts (1 mw -1,341 hp.).

The hydrogen will be stored in a 020-in stainless steel tank which is pressure stabilized (Pressurized helium would probably be used to replace the hydrogen as it is pumped out) For maximum protection against reactor radiation, payload and electronic equipment will be located on top of the hydrogen tank, i e , opposite from the powerplant end There is no provision made for shielding the liquid hydrogen tank from the reactor Assuming that the tank will subtend an angle less than 20 deg , Rom and Johnson calculate less than 1% of the hydrogen will be evaporated as the result of reactor operation and that any effective shielding would weigh more than the evaporated propellant

Solar shielding is another story To protect the liquid hydrogen from solar radiation during the long interplanetary trip, three lightweight reflectors, made from thin, gold plated plastic sheets, are located in front of the tank While coasting, the vehicle is pointed toward the sun to make effective use of the radiation shields

Should it become possible to increase operating temperatures from 4,500F to 6,000F, specific impulse will jump to 1,330 sec., propellant and tank weight will drop to 12,800 lb and this same rocket will be able to carry a 9,300 lb. payload.

If the initial weight of the vehicle in orbit is increased from 25,000 lb to 100,000 lb to provide for additional hydrogen, then the same nuclear powerplant (6.7 mw) will enable the vehicle to make a Mars round trip in 508 days with a 7,400 lb payload For a 4,500F operating temperature, payload capability on the 508-day mission would be 1,100 lb Total velocity increment required for the 508-day mission is 9 mi /sec

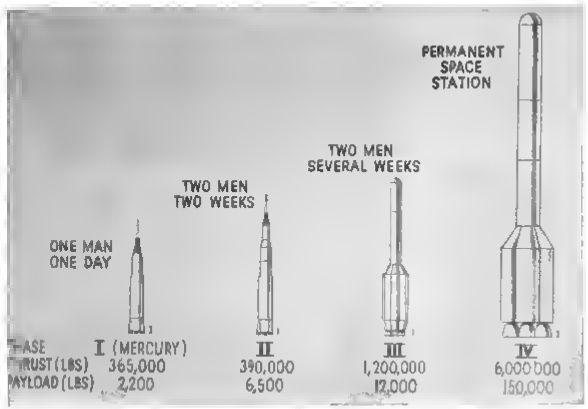
Scaling Up

For more ambitious missions, it will be necessary to scale up both the powerplant and the vehicle In the case of the 570-day, round trip Mars mission with a 49,000 lb payload (see table), for example, the total required velocity increment becomes 14 mi /sec and the power level of the reactor would have to be raised from 6 7 mw to 100 mw. Rom and Johnson believe this would prove a relatively simple task

Initial weight of the vehicle in orbit would go to 500,000 lb. Most of the additional weight will be taken up by hydrogen and its tankage Powerplant weight would increase from 2,400 lb to 17,000 lb Thrust would be scaled up from 330 lb to 35,000 lb To achieve the 49,000-lb payload capability, 6,000-F operating temperatures would be required At 4,500F operating temperatures, payload capability for this mission is only 7,500 lb (The 100,000-lb. vehicle could make this 570-day excess energy mission, but it would not be able to carry any payload unless operating temperatures were more than 5,500F)

By comparison, a chemical rocket with a specific impulse of 400 sec could not perform either the 508-day or the 570-day round-trip Mars mission It could make the 973-day minimum energy Mars round trip, but its payload capability would be only 1,800 lb —less than one third that of the low energy nuclear fission rocket On the other hand, a nuclear electric ion propulsion system with a specific impulse of 5,000 sec and an acceleration capability of 10^{-4}g (acceleration of the fission system is figured at approximately 10^{-3}g) could carry significantly more payload than the fission rocket on the two lower powered Mars missions, but its trip time will be considerably longer due to its low acceleration

It is unlikely that the nuclear electric system would be able to make the 570-day extra energy Mars round trip This mission calls for only a 30 day wait in Mars orbit (including time for acceleration and deceleration), and it is calculated to require a minimum acceleration of 2×10^{-4}g to accomplish this mission If some trajectory is found that will enable a nuclear electric rocket to carry out this mission, the system will have to achieve large amounts of additional energy at the expense of payload



NASA Plans Orbiting Laboratories

Development plans for the National Aeronautics and Space Administration's manned orbiting laboratories begin with the Mercury vehicle using an Atlas booster. Second is Vega, a modified Atlas with GE Vanguard for second stage and a third stage storable liquid engine Next are clustered engine vehicles concluding with concept of Nova (AW Mar. 30, p. 28).

1.5 Million lb. Rocket Test Unit Being Built

Construction of a rocket engine test stand for testing liquid-propellant rocket engines delivering up to 1,500,000 lb thrust is under way at Edwards AFB, Calif A contract in excess of $800,000 for basic construction of the facility was awarded Mid-Valley Utility Constructors, Inc , industrial builders and engineers of Houston, Tex., by Rocketdyne Division of North American Aviation Three-stand testing complex at Edwards will be operated by Rocketdyne for National Aeronautics and Space Administration

Western Electric Gets Anti-Missile Contract

Western Electric Co has been awarded an $8,671,000 Army contract for continued research and development work on the Nike Zeus anti-missile missile program Work under the contract will be performed at Bell Telephone Laboratories, Whippany, N. J., Douglas Aircraft, Santa Monica, Calif., Continental Can Co , Coffeeville, Kans , and Goodyear Aircraft Co , Akron, Ohio.

THE PRESIDENT'S MESSAGE

Why the jets? What prompts the scheduled airline industry to invest more than three times its net worth to buy new equipment? Why should the airlines and its industry organization spend so much time and trouble trying to convince Government agencies that the civil jet age will be a good thing for the nation and that a climate of freedom is essential? Why not give up in the face of obstacles, man-made and otherwise, and merely stick with what we have?

There are many answers to those questions. During the past few years of detailed planning and preparation, airline people have referred to them all. There is the obvious value of a mighty 600-mile-an-hour airlift, paid for by private money, and available under the Civil Reserve Air Fleet plan to the nation in time of emergency. There is also the equally obvious national interest value of effective competition on a world-wide basis with the civil jets of Aeroflot, the Russian airline.

However, I think if I were pressed to provide a single answer, I would do it in the words spoken to me recently by an executive of one of our member airlines. He said:

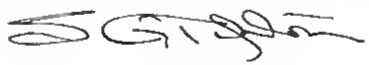
> "We're fighting to save time for people and time is just about the most precious possession people have."

It is that energetic desire to improve constantly its service to the public that has pressed the U S-Flag airlines forward into the jet age. This, of course, is not a new attitude on the part of the airlines. Although the jet re-equipment program is the most revolutionary, both in terms of managerial effort required and in terms of benefit for the nation, it is actually the fifth major equipment change since World War II.

The traveling public has responded to this airline desire to serve the public. It was a matter of considerable pride that in 1958, in spite of a general economic slump, that the airlines maintained the same traffic level as the year before, even while railroads and buses were slipping in passenger traffic.

The progress of the airlines in the last two decades has come about by a fruitful blend of cooperation and competition. Cooperation, that is, through the ATA and otherwise, in areas such as safety development, improvement of operational techniques, and in techniques designed to make things more convenient for the passenger or shipper. Competition, of a particular intense variety, is carried on in matters of sales promotion and market development.

The Congress, when it adopted the Civil Aeronautics Act in 1938 and enacted the Federal Aviation Act in 1958, directed the Government to promote the sound economic development of the air transport industry, legislated wisely and well. The future progress in the public interest now depends upon the ability of the industry and the Government to work together effectively in applying this Congressional mandate.



S G. TIPTON

Definition of Terms

Passenger Miles and Ton Miles

AVAILABLE SEAT MILES FLOWN. Total seat miles available for sales in scheduled service

AVAILABLE TON MILES. Total ton miles of lift capacity available for sales in scheduled and charter service

CHARTER FLIGHT. Transportation of passengers or property on other than scheduled and designated extra section flights

EXPRESS TON MILE. A ton of express flown one mile

FREIGHT TON MILE. A ton of freight flown one mile.

PASSENGER MILE. One passenger flown one mile

PASSENGER LOAD FACTOR. The percentage of available seat miles actually sold in scheduled service

PASSENGER TON MILES. Passenger miles converted to ton miles. (See definition of revenue ton miles.)

REVENUE PASSENGER MILES. The number of fare paying passengers flown times the length of trip in miles. This is the amount of available seat miles sold.

REVENUE PLANE MILES. Aircraft miles flown in scheduled service

REVENUE TON MILES. The ton miles sold in scheduled and charter service. In the construction of this traffic measure passenger miles are converted to ton miles on the basis of about 10 to 1. That is, ten passengers with allowable free baggage are accepted as equalling one ton

SEAT MILE. One passenger seat filled or unfilled flown one mile

TON MILE LOAD FACTOR. Percentage of available ton miles sold in scheduled and charter service

U S MAIL TON MILE. A ton of mail flown one mile. The mail figures are in two categories. These are defined as Priority and Non-Priority. Priority mail includes air mail and air parcel post. Non-priority mail is first class mail that moves in air service. At present non-priority mail is being flown on an experimental basis between certain selected cities.

Revenues and Profit and Loss

EXPRESS REVENUE. Revenues accrued from the carriage of express

FREIGHT REVENUE. Revenues accrued from the carriage of freight

INCOME TAXES. Federal income taxes

NET OPERATING INCOME. The total operating revenue from air transportation services less the operating expenses (see definition of Operating Expenses). Net Operating Income is before taxes and interest charges and does not include non-operating items

NET PROFIT OR LOSS. Net income after Federal income taxes—the amount available for dividends or investment in the business. This figure is subject to change because of the later adjustment of some accounting transactions and through revision of mail rates and subsidy by regulatory action

OPERATING EXPENSES. The expenses incurred in the conduct of the business except for such items as debt financing and other non-operating items

RATE OF RETURN ON INVESTMENT. Total return i.e. net profit plus interest paid on long term debt as percent of average investment. Investment is the average of total net worth (stockholders equity) plus long term debt at the beginning and end of the year

PROFIT MARGIN ON SALES. Net profit after interest and after taxes as per cent of operating revenues

OTHER REVENUE. All other revenues, including excess baggage, chartered services, foreign mails, penalties for failure to cancel reservation, service charges on non-revenue transportation of employees and special services such as photography and crop dusting

PASSENGER REVENUES. Passenger revenues from scheduled operations

PUBLIC SERVICE REVENUES. Payments by the Federal Government to insure air service to communities in the United States and its territories which could not otherwise afford it, to maintain essential international air routes which are not yet self-supporting, and to develop helicopter service

U S MAIL REVENUE. Service revenue for the transportation of mail. This is the amount paid by the Post Office to purchase air transportation for mail, and is not subsidy

Air Transport

FACTS AND FIGURES

20th Edition, 1959

The year 1959 is the first year of air transport operation under the new Federal Aviation Act, passed last year. To demonstrate how the industry has increased its public usefulness over the years, this edition of Facts and Figures compares two decades of growth by showing figures for 1939, 1949, and 1958. In addition, the three years prior to 1958 are listed to show a more recent pattern of growth. Revised data filed by the scheduled air carriers with the Civil Aeronautics Board and the records of the Interstate Commerce Commission served as the major sources of the statistics.

THE YEAR IN REVIEW

1958 was the twenty-first year of airline operations under the Civil Aeronautics Act. The year saw, not only the inauguration of commercial jet transportation, but other developments that will also have significance in the years to come.

● **The Federal Aviation Act.** During the year, the Congress enacted the Federal Aviation Act of 1958. The Act repeals the Air Commerce Act of 1926 and the Civil Aeronautics Act of 1938. It created the Federal Aviation Agency with this objective: "To provide for the safe and efficient use of the airspace by both civil and military operations, and to provide for the regulation and promotion of civil aviation in such manner as to best foster its development and safety."

Incorporated into the new agency are the Civil Aeronautics Administration, the Airways Modernization Board, and the safety-rulemaking authority of the Civil Aeronautics Board.

The Administrator, E. R. Quesada, appointed by the President, has the authority to "regulate establish, operate and improve air navigation facilities; to prescribe air traffic rules for all aircraft; and to conduct related research and development activities."

● **The Charington–Quasada Report.** This important report, "The Status and Economic Significance of the Airline Equipment Investment Program," was sent to Congress by President Eisenhower in August. Written by Paul W. Cherington, Professor of Business Administration, School of Business, Harvard University, it was presented to the President by E. R. Quesada, the President's Special Assistant for aviation matters.

Writing to Congress, President Eisenhower said: "This report sets forth, in some detail, the present status of the major air carriers and discusses their ability to implement their investment program of approximately $4 billion in aircraft and equipment. This program is of such a size as to hold some significance to the national economy over the next few years."

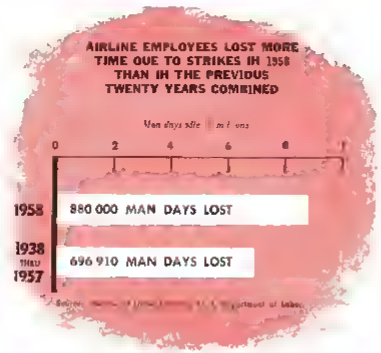
● **The Transportation Tax.** In 1958, the three per cent tax on shipment of freight for hire carriers was repealed.

Still remaining is the 10 per cent Federal transportation tax on passengers.

● **Balance at the Bargaining Table.** In November, six airlines joined in an agreement that allows limited financial assistance to those members of the agreement shut down by strikes. The payments are based on the additional net revenues received by the carriers still in operation.

The agreement was presented to the Civil Aeronautics Board and in a press release decision the CAB said the plan was "not adverse to the public interest and should be approved."

This plan was advanced by the airlines to deter strikes which in 1958 alone forced cancellation or disruption of the travel plans of over 2,500,000 passengers.



Historically, airlines have not had the economic resources to withstand long and costly strikes. This situation has led to an imbalance at the bargaining table where labor uses the strike, and the strike threat, most effectively. Most airline unions are national in scope and for years have employed various forms of mutual aid to assist one another.

● **The Airlines Hold the Line.** Despite the continually upward spiraling of costs over the last 20 years the scheduled air carriers of the U. S. are now offering the public a fare level only 3.2 per cent greater than the 1939 level.

During this time, the airlines have greatly expanded their usefulness by adding more cities to their network, carrying more passengers, more freight and by increasing their service to the Post Office Department.

Their contribution to the national defense has also increased. Today, more than 300 long-range, four-engine aircraft are available to the Department of Defense on 36 hours' notice for airlift in the event of a national emergency.

On Stage in 1958—The Civil Jet Age

Last year, the first U. S. commercial pure jet planes went into scheduled operation.

Observers were quick to note the many benefits that will flow from this new era in public transportation. The speed of the new planes, the comfort they will afford passengers, the almost-revolutionary changes that will improve the lot of the traveler, shipper and postal user, were all cited as some of the major benefits.

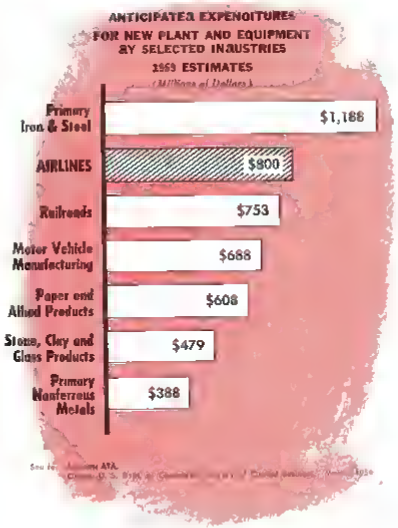
This Age means business, not only in terms of the multi-billion-dollar investment that will go into the planes and the supporting equipment right now, but more importantly, in the years to come.

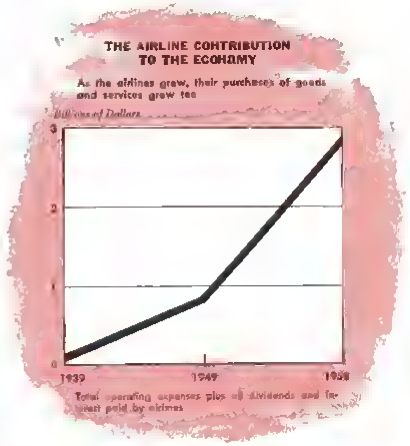
Here is how the investment will be apportioned:

- $2,500,000,000 for new aircraft, along with spare parts and engines.
- $ 250,000,000 for supporting ground equipment, hangars, maintenance bases and other equipment.
- $ 220,000,000 to be spent by others for facilities but to be taken over, and paid for, by the airlines.

The investment for 1959 alone compares favorably with the capital expenditures of basic manufacturing industries.

The overall importance of the investment to the general economy promises to have a far greater, and more lasting, benefit in the long run than the temporary pump-priming effect of the aircraft orders.





The investment is radiating out into the nation's economy, creating more jobs, and making existing jobs more secure, by the need to, (1), supply the airline orders, and; (2), maintain this enormous fleet when it is delivered and in scheduled service.

Mr. Cherrington estimated that the jet program of the airlines directly involves an average of 80,000 to 125,000 net additional jobs annually in the economy and indirectly still more.

He also saw the equipment program of the airlines as a matter of "direct concern" to the income of 5,000 business firms.

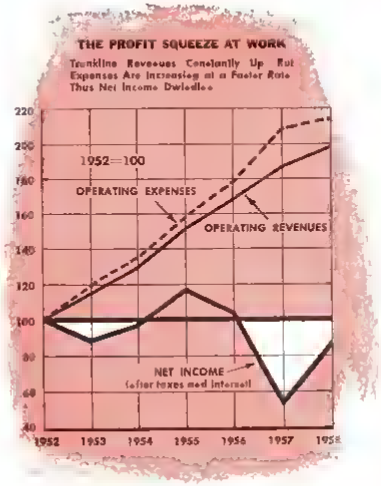
The airlines are good customers of more than 10,000 different concerns who supply the more than 100,000 different items that carriers need.

Last year their spending reached an all-time peak when they pumped back into the economy more than two billion dollars to suppliers, employees and, through taxes, to Federal, state and local agencies.

The largest part of this re-investment in the economy was for wages and salaries, a total payroll of about $950,000,000. The rest of the airline expenditures were spread out over an almost infinite list of supplies; from thumb tacks to the enormous, and expensive, rubber tires for the aircraft themselves.

A Look at Airline Earnings

Financially, 1958 was the same kind of frustrating year that the air transport industry had experienced in 1957; record-breaking revenues, all-time highs in traffic but, when all the bills were paid, a net profit that remained at a critically low level.



Specifically, the airlines of the United States last year took in $2,237,469,000 in operating revenues, spent $2,131,542,000 for operating expenses and kept only $52,914,000 as a net profit, after taxes and interest.

The revenue and the expense figures were the highest ever; the net profit compares with $56,046,000 in 1951 when the airlines grossed $1,019,672,000, less than ½ of the 1958 level.

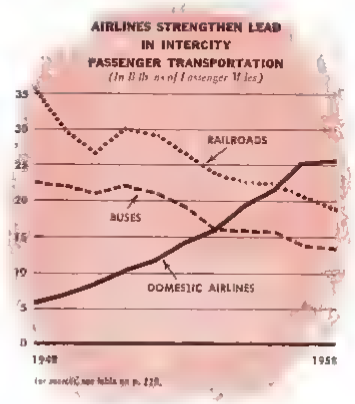
The Civil Aeronautics Board granted two temporary fare adjustments during the last year. Approximately 70 million dollars were added to domestic airline revenues because of these fare adjustments:

- On February 10, the CAB authorized the domestic airlines to raise their basic fares by 4 per cent, in both first class and coach and add $1 per ticket.
- In October, the CAB permitted the domestic airlines to eliminate the roundtrip discount of 5 per cent, remove the free stopover privileges, and reduce the discount for family dependent travel from 50 per cent to 33⅓ per cent.

Airline Traffic Continued to Gain

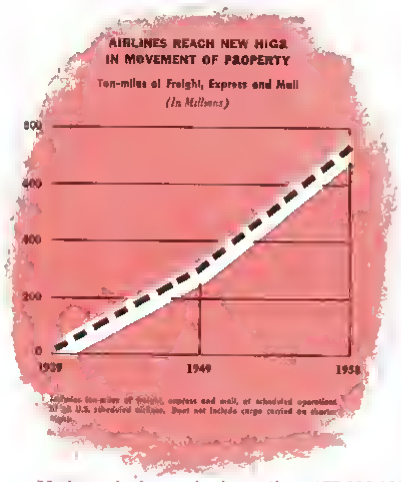
Overall, airline traffic showed an increase over 1957. This increase was significant when viewed against the backdrop of a nationwide recession during part of the year and a series of airline strikes during the latter part of the year.

The domestic airlines, compared with their public transportation competitors, the railroads and the buses; more than held their own. While



the airlines maintained their 1957 level, the railroads' passenger traffic dropped 14 per cent and the buses dropped two per cent.

For 1958 compared to 1957, the scheduled airlines operated a record high of revenue ton miles, 4,075,000,000, but it was only a 1 8 per cent increase over the previous year.



Mail reached new highs with a 177,000,000 ton-mile haul. Express was up six per cent to a new peak of 48,837,000 miles but freight traffic, due to the cessation of common carriage by one of the major all-cargo carriers, showed a drop.

Progress Under the Aviation Acts

During 1958, the Civil Aeronautics Act of 1938 was succeeded by the Federal Aviation Act of 1958. The promotional provisions of the original act were carried through without a word changed. That provision, the basic tenet of the Civil Aeronautics Board, is: "The encouragement and development of an air transportation system properly adapted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service and of the national defense."

In 1958, the twenty-first year of operation under the Acts, the airlines have reached new peaks of usefulness in every category.

This growth has been possible because the airlines in their efforts to serve the public have provided service in continuously greater abundance, while improving their dependability over the years.

The air transport industry has been aided by public service revenues, or subsidy, just as the waterways and railroads were helped when they were young industries.

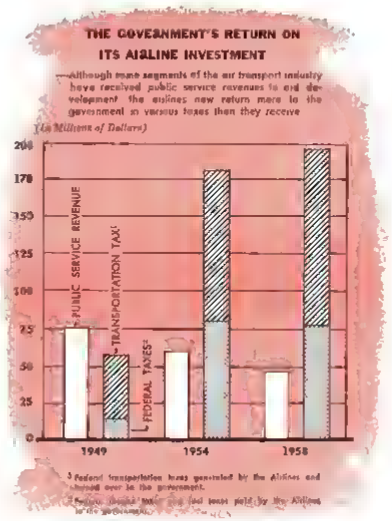
THE AIRLINE STORY

1949 Increasing Usefulness Over The Years

All classes of Certificated Air Carriers	1939	1949	1958
Number of Airlines	23	45	55
Cities Served (excluding Alaskan points) [2]	206	638	703
Aircraft in Service	347	1,083	1 900
Seats Available (daily)	5 100	35 900	103 700
Cruising Speed of Fastest Transport	220 mph	315 mph	590 mph
Number of People Employed	13 300	76 000	146 000
Total Airline Payrolls	$24 000 000	$349 000 000	$950 000 000
U S Mail Ton Miles	8 610 000	61 144 000	177 430 000
Number of Passengers Carried	1 864,000	16,723 000	49 075 000
Average Fare	5 62¢	6 23¢	5.8¢
Ton Miles of Freight Carried	2 713 000 [1]	112,500 000	501 591 000

[1] Freight and Express combined

[2] Early figures for Alaska not available but in 1958 there were 268 points served



While the total amount of aid that has been given to the domestic airlines since 1938 is small in relation to many other support programs of the United States government, the country has benefitted from the investment in an actual return that now approaches the billion-dollar-mark.

Subsidy now accounts for only 2 2 per cent of the total airline revenues. The greater part of the government aid today goes to the local service airlines in order to guarantee air service to smaller communities. Other subsidy payments go to help develop the experimental helicopter service in three cities, for Alaskan airlines, and to maintain national interest routes in Latin America. No domestic trunk line is now receiving subsidy.

Safety in the Air

The number one concern in the airline industry last year, as it has been in every year, was the matter of safety in the air.

The airlines in cooperation with the Civil Aeronautics Administration, now part of the Federal Aviation Agency, and the military services, have been working toward reducing the hazard of mid-air collisions by seeking a means of positive separation of aircraft flying the nation's airways.

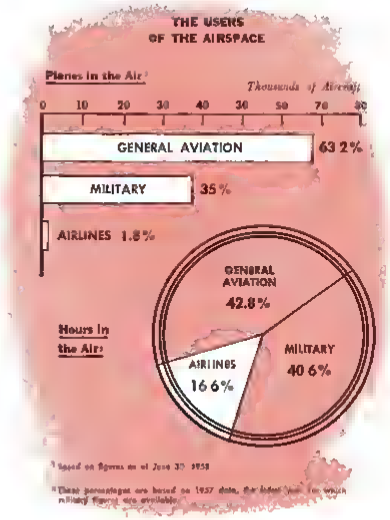
The airlines had voluntarily placed all of their planes flying above 18,000 feet on instrument flight rules, which meant that above that altitude, all airliners were separated from each other. This level was lowered in mid-1958 to the 10,000 foot level. During the year, the military also adopted some restrictions of "see-and-be-seen" operations.

Another step to make air transportation still safer was the setting up, by the Civil Aeronautics Board, of three Super Skyways that connect New York and Washington with Los Angeles and San Francisco. These special airways extend from 17,000 to 22,000 feet and no airplane is permitted to use, or even cross, these airways without specific permission of the traffic control centers.

Plans are now underway to extend this system of positive control highways to other parts of the air traffic control system.

Air Traffic Control and the New Jets

The new jets flying greater speeds and at higher altitudes, will be handled in the existing



system, but with special consideration. Working with the close cooperation of the military, the high-flying jets will be tracked, and radar separation will be provided, for aircraft operating above 24,000 feet. This is being done by FAA traffic controllers and utilizes the existing long-range radar of the Air Defense Command.

The airspace—that rapidly dwindling natural, and public, resource—has now for the first time been placed under single, and unified, management. The management is the Federal Aviation Agency.

The Air Force estimates that the military planes fly about ten million hours a year—within the continental U.S. The general aviation planes fly about 11½ million hours a year and the airlines about 4½ million hours.

Complicating the problem of allocation is the fact that not all of the navigable airspace can be used. Areas around radio-TV towers and tall buildings and over natural preserves are closed off to all kinds of flying. Also, some 130,000 square miles over the continental U.S. are closed off to non-military flying.

The end result of the planning on the part of the airlines and the government, with the cooperation of the other users, the military and general aviation, has as its ultimate goal, safety.

The safety record of the airlines has demonstrated the wisdom of advanced planning, and the manufacturers ceaseless search for equipment and devices that will make flying safer today than it was yesterday, and safer tomorrow than it is today.

The record: In the last seven years, the domestic scheduled airlines in 1954-58 had a fatality rate of .38 per hundred million passenger miles compared to 2.55 in the 1939-43 period.

DOMESTIC TRUNKLINES

The domestic trunk airline industry gained in all categories of traffic except one in 1958. Revenue ton miles flown in domestic operations totaled 2,750,900,000, an increase of 1.1 per cent.

The 12 trunklines flew a total of 24,435,700,000 passenger miles in scheduled service over their domestic routes in 1958, a decline of 0.3 per cent from 1957.

Domestic trunkline freight traffic increase 10.1 per cent to 240,510,000 ton miles in 1958.

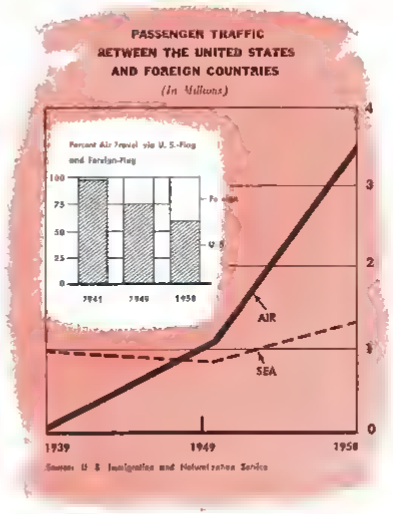
The trunklines gained also in mail and express volume. They flew 45,890,000 ton miles of air express, an increase of 7.3 per cent, 87,809,000 ton miles of air mail, up 7.0 per cent; and 16,155,000 ton miles of non-priority mail, a gain of 6.7 per cent.

Revenues reached a record high of $1,513,019,000 in 1958. However, expenses also rose to an all-time high; $1,418,486,000, leading to a net profit of $44,709,000 for the year. While $17,721,000 higher than in 1957, the 1958 net profit was $13,003,000 less than that in 1956 and about equal to 1951 earnings.

Trunkline jet programming indicates that a total of 62 pure-jet and 185 prop-jet airliners will have been delivered the end of 1959.

INTERNATIONAL AIRLINES

The fastest service in international airline history was introduced in 1958 but U.S.-flag airlines saw their share of the total market continue to shrink. Two-thirds of the increased air travel between the U. S. and foreign countries was secured by foreign flag airlines.



It was a record year for traffic. U.S.-flag airlines flew an all-time high of 5,974,600,000 revenue passenger miles, up 3.9% from the previous record total of 5,751,700,000 in 1957. Cargo ton-miles reached a new high of 128,925,000 for an increase of 4.6% over 1957.

The gap between air and sea travelers widened with air traffic accounting for three-fourths of the total U.S.-foreign market. But increased competition from foreign flag airlines was evident as those carriers, for the first time, carried more passengers to and from the U.S. than all steamship companies combined, increased their share of the total U.S.-foreign air market to 40% and, in such vital areas as the North Atlantic, widened their share to 59% by year end.

LOCAL SERVICE AIRLINES

Major objectives of the local service airline industry are fleet modernization to increase efficiency, improve service and stimulate traffic and to reduce subsidy. Two carriers introduced turbine-powered aircraft in 1958. Several others are introducing turbine aircraft and more efficient piston-engine airliners during 1959.

Guaranteed loan and related federal legislation aimed at facilitating the re-equipment program aided developments during the year. A capital gains bill, enacted in 1958, permits local service airlines to apply profits from the sale of older aircraft to the purchase of modern planes. Formerly proceeds were deducted from public service revenues.

While beneficial in securing equipment financing, these measures do not substitute for adequate earnings. In the "Local Service Rate of Return Case" before the Civil Aeronautics Board, the carriers are seeking regulatory policies that will provide opportunity for reasonable earnings. The Board has stated it will improve the regulatory framework and has taken some steps in that direction.

The local airline service pattern continues to expand rapidly. The 13 carriers were operating 35,586 unduplicated route miles at the end of 1958, some 2,000 miles more than a year earlier.

The number of cities served increased from 468 to 516 at the end of the year. It is significant that 283 of those communities would other-

wise be without scheduled airline passenger, mail and freight service.

The local service airlines gained in all categories of traffic in 1958. They carried 4,265,000 persons in scheduled service—10 times more than 11 years previously. They flew 820,200,000 passenger-miles, an increase of 9.8 per cent over 1957.

Because of traffic development and efficiency gains, the proportion of federal support has declined sharply. Public service revenues have dropped from about 65 per cent of total revenues in 1948 to 34 per cent in 1958.

HELICOPTER CARRIERS

During 1958, the scheduled helicopter carriers continued their upward traffic trend registered so markedly the previous year.

Revenue ton miles, the overall indicator of activity, were up 33.5 per cent for the year, from 448,000 to 598,000 a new high.

The helicopter lines carried 228,000 passengers during the year, a 54.1 per cent increase over the previous year. The passenger-mile figure was up, too, during 1958. The lines operated 4,885,000 passenger miles, a 43.9 per cent gain over the year before.

Available ton miles were at a new peak. The helicopter lines operated 1,497,000 available ton miles in 1958, compared with 1,056,000 in 1957, a gain of 41.8 per cent.

Together, the three helicopter lines operate 22 aircraft over 905 route miles serving 29 points.

THE ALASKAN CARRIERS

Alaska's entrance into the Union in the late summer of 1958 bodes well for future travel to our 49th State. A spokesman for the scheduled airline industry puts it this way:

"With admission of Alaska to statehood, our national frontiers have been materially broadened. As a result, added traffic volume is anticipated both from increased tourism and from the greater influx of industry and population. Routes covered by the Alaskan carriers serve the most densely populated and industrialized areas of Alaska and the airlines (Alaskan) should continue to participate in the future growth of the new State."

Revenue ton miles were up over 1957, 32,901,000 versus 32,513,000—a 1.2 per cent gain.

The Alaskan carriers flew more passengers during the year than they did the year before. 315,000 passengers were flown compared with 309,000 during 1957. Passenger miles were up, also, with 1958 showing an all-time peak of 163,800,000, 7.8 per cent over 1957.

TERRITORIAL CARRIERS

The territorial carriers flew more revenue ton miles in 1958 than in any previous year.

They reached 11,264,000 a gain of 24.3 per cent over 1957 when 9,065,000 revenue ton miles were flown.

Freight ton miles were up, to 1,587,000 from 1,536,000 a gain of 3.3 per cent.

In scheduled passenger operations, the territorial carriers dropped below the 1957 results. They carried 572,000 passengers in 1958 compared with 589,000 the year before. Similarly, the passenger mile figure was down, from 1957's 89,500,000 to 82,700,000 a drop of 7.6 per cent.

Total operating revenues reached a new high with a $9,396,000 total. Total operating expenses were $9,254,000 and net income, $142,000.

THE ALL-CARGO LINES

The all-cargo lines after allowing for the dropping of service by a major cargo-carrier show a gain of 18 per cent over the prior year.

On an industry basis their freight ton miles, which had been rising steadily, dropped back 21 per cent with a total 121,382,000 ton miles versus 155,126,000 for the previous year.

Total operating revenues for the all-cargo lines were $78,908,000 for the year.

Priority U.S. mail was also up for the year, with 2,040,000 ton miles flown as against 440,000 during 1957.

U. S. Scheduled Airline Industry

(For Selected Years, In Millions)

THIS TABLE SHOWS THE EVER INCREASING GROWTH IN THE SERVICES THE SCHEDULED AIRLINES ARE OFFERING TO THE PUBLIC AND THE INCREASING USE OF THIS SERVICE BY THE PEOPLE THE GOVERNMENT AND SHIPPERS.
LOAD FACTOR IS THE PERCENTAGE OF CAPACITY WHICH IS SOLD.

	Available Ton Miles Flown	Revenue Ton Miles Flown	Ton Mile Load Factor (%)	Available Seat Miles Flown	Revenue Passenger Miles Flown	Passenger Load Factor (%)	Revenue Plane Miles Flown
Domestic Trunk Airlines							
1939	N.A.	76.5		1,209.6	654.0	54.07	82.8
1949	1,517.4	801.2	52.80	11,117.7	6 570.7	59.10	323.2
1955	3 882.7	2.160.1	55.63	30 001.3	19,217.2	64.05	864.0
1956	4 393.2	2.417.0	55.02	33.752.6	21 643.1	64.12	622.1
1957	5 150.4	2.720.0	52.81	39.838.2	24 499.5	61.50	711.1
1958	5,190.2	2,750.9	53.00	40 695.0	24 435.7	60.05	700.6
Local Service Airlines							
1939'							
1949	46.4	14.2	30.69	477.9	134.7	28.18	24.5
1955	121.9	55.3	45.36	1 161.4	523.3	48.06	50.9
1956	145.6	66.8	45.91	1 385.0	633.2	45.72	59.8
1957	170.7	78.5	46.00	1 653.8	747.3	45.19	67.3
1958	185.4	86.6	46.71	1 793.5	820.2	48.73	72.3
Territorial Airlines							
1939	N.A.	3		5.8	3.1	56.74	.4
1949	10.1	5.2	51.45	91.3	52.6	57.19	4.0
1955	16.1	8.4	52.10	134.7	78.1	57.99	4.6
1956	16.0	8.8	53.03	147.9	83.9	56.70	4.6
1957	15.7	9.1	57.96	154.9	89.5	57.78	4.7
1958	18.4	11.3	61.41	143.1	82.7	57.79	4.4
Helicopter Airlines *(in thousands)*							
1939'							
1949	142	46	32.39				412
1955	434	195	44.93	1 708	628	36.77	1,148
1956	567	277	49.03	3 561	1 588	44.59	1,315
1957	1 056	448	42.42	8,049	3 272	40.66	1 604
1958	1,497	598	36.95	11,419	4,885	42.78	1,678
International and Overseas Airlines							
1939	N.A.	77.2[2]		134.4	71.8	53.46	7.6
1949	540.3	309.5	57.28	3 624.7	2 054.0	56.67	104.5
1955	984.6	633.8	64.37	7,012.1	4 410.8	62.90	130.7
1956	1,143.4	741.2	64.82	8,073.1	5 113.2	63.34	146.0
1957	1 292.9	827.0	63.96	9 038.1	5 751.7	63.64	185.7
1958	1,426.6	873.1	61.20	10 057.6	5 974.6	59.40	165.5
Alaskan Airlines							
1939'							
1949	20.3	11.2	55.32	38.9	15.4	39.64	3.9
1955	46.0	29.4	63.87	233.9	110.4	47.20	10.5
1956	66.9	44.8	66.98	284.1	137.0	48.21	11.3
1957	59.4	32.5	85.08	329.7	151.9	46.07	11.5
1958	59.9	32.9	54.94	369.0	163.8	44.39	11.5

See Footnotes at End of Table on Page 116

Available Service and Utilization *(continued)*

	Available Ton Miles Flown	Revenue Ton Miles Flown	Ton Mile Load Factor (%)	Available Seat Miles Flown	Revenue Passenger Miles Flown	Passenger Load Factor (%)	Revenue Plane Miles Flown
All-Cargo Airlines							
1939[1]							
1949[1]	16 5	11 7	70 20				2.8
1955	184 0	135 t	73 41				17 t
1956	321 6	248 8	77 38				23.5
1957	431 7	336 9	78 04				23.3
1958	383 8	319 3	83 20				16 1
CONSOLIDATED INDUSTRY							
1939[1]		154 0[2]		1,349 5	728 9	54 01	90 8
1949	2,151 0	1,153 1	53 61	15,350 5	8 827 4	57 50	462 9
1955	5 235 7	3,022 2	57.72	38 545 t	24,340 4	63 15	779 0
1956	6,087 1	3,527 4	57 95	43,646 3	27,612 0	63 26	868 4
1957	7,121 5	4,004 4	56.23	51,022 7	31,243 t	61.23	975 3
1958	7,265 7	4,074 7	56 08	53,069 6	31 481 9	59 32	972 t

Data not available for Alaskan airlines in 1939.
Local Service operations initiated in 1945
Helicopter operations started in 1947, passenger service began in 1953
All Cargo Airlines began operations in fourth quarter of 1949

[2] Revenue Ton Miles data for items other than passenger ton miles for International and Overseas carriers not available for 1939, hence total does not reflect these items

N.A. Not Available

Note: Available Ton Miles and Revenue Ton Miles include charter operations; all other items are for scheduled service only.

PERSONNEL EMPLOYED BY THE SCHEDULED AIRLINE INDUSTRY

(1940-1958)

Year	Pilots and copilots	Other Flight Personnel	Pursers, Stewards, Stewardesses	Communications personnel	Mechanics	Aircraft and traffic servicing personnel	Office employees	All others	Total
1940	2,279	33	1 036	193	8,413	4 277	7,689	1 131	22 051
1941	2 664	49	1 210	220	6 389	4,931	9,710	1 285	26 458
1942	3 146	241	1 131	1 610	12 882	7 384	11,083	2,236	39,713
1943	2 332	330	992	2 196	10 411	5,191	12,832	4 995	39 279
1944	3,345	277	1,516	2,501	9 963	5 748	15,234	4 023	42 607
1945	5 897	1 046	2 486	3 477	15 943	9 447	23 904	6 081	68 281
1946	7,220	t 503	4,421	5 031	23 376	12 770	31 587	10 646	96 554
1947	6 637	1 333	4,077	3 829	21,140	11,610	32,691	3 835	85 152
1948	6926	1 515	4 142	3 661	21 828	11 662	31 145	3 729	84 608
1949	6 843	1 602	4 341	3 581	19 535	11 674	30,148	3 270	80 994
1950	7,277	1,521	4 427	3 403	19 606	12 256	31 138	3 158	82 786
1951	8 386	1 708	5 303	3 618	23 477	14 370	35.081	3 810	95 753
1952	8 770	1 852	5 859	3 653	26 162	15 588	37 894	4 294	104 072
1953	9 437	2 146	6 106	3 567	26 105	17 353	40 319	4 359	109,392
1954	9 495	2 525	6 363	3 332	25 173	17 855	40 670	4 128	109 541
1955	10 857	2 762	7 454	3 499	29 196	19 114	45 030	4 291	122 203
1956	11 386	3 384	8 097	3 605	30 962	20,657	49 336	4 076	131 503
1957	13 286	3 797	9 450	4 004	34 162	36 052	31 799	17 640	147 190
1958	12 944	3 829	9,847	3 908	29 221	35 415	29 602	18 103	142 869[1]

[1] These are preliminary figures based on reports from a majority of the airlines as of September 30th.

REVENUE TON MILES OF TRAFFIC CARRIED

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Revenue Ton Miles)

THIS TABLE SHOWS BY CATEGORIES THE EVER INCREASING USE OF THE SCHEDULED AIRLINES BY PASSENGERS AND COMMERCE

	Passenger[1]	Priority U. S. Mail	Non Priority[3] U. S. Mail	Express	Freight[2]	Charter Flights	Excess Baggage[4]	Total
Domestic Trunklines								
1939	64 577	8 608			2 705		597	76 487
1949	624 219	40 874		27 329	94 190	7 483	7 102	801,197
1955	1 825 631	71 859	14 175	49 603	174 017	5 737	19,046	2,160 068
1956	2 056 098	77 788	13 891	49 709	190 592	5 911	23 055	2,417 044
1957	2 327 334	82 057	15 137	42 752	218 432	6 335	27 983	2 720 030
1958	2 321 347	87 809	16 155	45 890	240 510	12 000	27 237	2 750 948
Local Service Airlines								
1939[1]								
1949[1]	12 796	428		320	436	194	60	14 234
1955	49 713	928	328	1 403	1 365	1 338	245	55 310
1956	60 156	1 192	344	1 687	1 624	1 520	320	66 843
1957	71 079	1 174	345	1 642	2 082	1 717	471	78 510
1958	78 055	1 330	395	1 801	2,241	2 196	575	86 593
Territorial Airlines								
1939	299	2			8	n.a	2	311
1949	4 206	70		124	618	123	66	5 207
1955	6 250	59		n.a	1 646	436	20	8 411
1956	6 710	63	2		1 475	236	17	8 503
1957	7 259	63	1		1 536	170	36	9,065
1958	6 611	67	2		1 587	2 965	32	11 264
Helicopter Airlines								
1939								
1949		46						46
1955	60	96		31	5		3	195
1956	149	89		31	7		1	277
1957	311	92		33	8	3	1	448
1958	465	84		34	6	6	3	598
International and Overseas Airlines								
1939	77 233	n.a		n.a	n.a	n.a	n.a.	77 233[1]
1949	220 805	19 772		49 444	6 714	3 233	9 515	309 483
1955	453 195	52 409		243	90 598	19 701	17,648	633 794
1956	524 369	55 158			109 235	32 652	19 757	741,171
1957	589 510	57 265			123 280	36 188	20 771	827 014
1958	597,326	65 825			128,925	60 832	20 195	873 103
Alaskan Airlines								
1939[1]								
1949	1 659	479			618	8 449	27	11 232
1955	11 868	2 279			7 300	7,773	152	29 372
1956	14 719	2 383			7 948	19 527	241	44 818
1957	16 002	2 695			7 201	6 344	271	32 513
1958	17 289	3 102			6 940	5 270	300	32 901

See Footnotes at End of Table on Page 108

Revenue Ton Miles of Traffic Carried *(continued)*

	Passenger[4]	Priority U S Mail	Non Priority[5] U S Mail	Express	Freight[6]	Charter Flights	Excess Baggage	Total
All-Cargo Airlines								
1939[1]								
1949[1]					10,542	1 124		11 666
1955			318		107 945	26 796		135 059
1956		381	1 188	1 266	140 420	105 526		248 781
1957		440	1 409	1 639	155 126	178 249		336 862
1958		2 040	621	1 112	121 382	194 104	61[7]	319 320
CONSOLIDATED INDUSTRY								
1939	142 109	8 610			2 713		599	†54,031
1949	863,685	61,669		77 217	†13 †18	29 606	16 770	1,153 865
1955	2 346,717	127,630	14 021	51 280	282 866	61 781	37 114	3 022 209
1956	2,662,201	†37,054	†5 425	52,693	451,301	165,372	43,391	3,527 437
1957	3,011,495	†43 786	†6 892	46,065	507,665	229,006	49,533	4,004 442
1958	3,021 893	†60 257	17,173	48,037	501,591	277,373	48,403	4,074,727

n a Not Available
[1] Data not available for Alaskan airlines in 1939 All Cargo airlines began operations in fourth quarter of 1949
Local Service operations initiated in 1945
Helicopter operations started in 1947, passenger service began in 1953
[2] Express and freight combined for all carriers in 1939 and for Alaskan carriers in all years
[3] Revenue Ton Mile data for items other than passenger ton miles for International and Overseas carriers not available for 1939 hence total does not reflect these items

[4] Foreign mail carried by International and Overseas airlines is included in Excess Baggage Therefore it is also reflected in Consolidated Industry Excess Baggage data
[5] See definitions p 3
[6] Passenger ton miles for years prior to 1957 were revised to conform with "standard" passenger weights as prescribed by the CAB effective Jan 1, 1957
Foreign mail Seaboard and Western.

AIRCRAFT OPERATIONS AT FAA AIRPORT TOWERS

1950-1958 (In Thousands)

Type of Flight Operation	1950	1951	1952	1953	1954	1955	1956	1957	1958
Military	2 384	2 852	2 983	3 712	4 409	4 957	5 472	5 910	5 565
General Aviation	9 585	9 618	7 965	7 719	8,015	8,540	10 021	12 129	14 037
Air Carrier	4 002	4 556	4 866	5 384	5 521	5 983	6 553	7 112	6 998
Total	15 971	17 026	15 814	16,815	17,945	19 480	22 046	25 151	26 600
% Air Carrier of Total	25 1	26 8	30 6	32 0	30 9	30 7	29 7	28.3	26 3

Air Carriers include scheduled and non scheduled operations. Each landing is counted as an operation as is also each take off

OPERATING REVENUES

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS THE DOLLARS OF SALES THE SCHEDULED AIRLINES EARNED FOR THE VARIOUS SERVICES THEY RENDER

	Passenger	U S Mail Priority	U S Mail Non-Priority	U S Mail Public Service Revenue[1]	Express	Freight	Other[4]	Total
Domestic Trunk Airlines								
1939	34 484	18 436				1 605	1 002	55 527
1949	378 113	45 031			8 957	18 323	9 359	459 783
1955	1 021 855	24 230	2 708	3 192	19 405	39 605	22 353	1 133 348
1956	1,142 197	28,937	2,654	2 609	18 101	42 173	26 160	1 262 831
1957	1 287 172	31 002	2 760	1 182	14 667	49 870	32 961	1 419 614
1958[2]	1,362,791	33,052	3,076	2,373	16 096	87,336	38 295	1,513 019
Local Service Airlines[3]								
1939								
1949	7 362	13 533			114	138	271	21 418
1955	32 840	1 084	101	20 923	665	856	1,281	57 450
1956	40 166	1 004	102	23 211	775	750	1 704	67 712
1957	47 464	1,108	103	29 651	725	1 049	2 039	82 139
1958[2]	56,421	1,254	116	32 523	796	1,183	2 361	94 654
Territorial Airlines								
1939	389	45				14[5]	3	421
1949	3 799	247			145	333	254	4 778
1955	5 696	48		291		752	337	7,114
1956	6 042	81	1	288		782	266	7,430
1957	6 975	51	2	72		781	479	8 360
1958[2]	7,066	55		109		819	1,347	9,396
Helicopter Airlines[5]								
1939								
1949		522						522
1955	208	250		2 710	100	23	64	3 355
1956	438	234		2 833	115	28	63	3 711
1957	968	237		3 567	101	36	123	5 032
1958[2]	1,460	214		4 091	102	31	117	6 015

See Footnotes at Bottom of Page 110

Operating Revenues
(continued)

International and Overseas Airlines	Passenger	U S Mail Priority	U S Mail Non Priority	Public Service Revenue[1]	Express	Freight	Other[4]	Total
1939	6,156	11 066				613	1 819	19 653
1949	158 480	75 197			20 023	2 105	18 350	274 155
1955	294,828	28 639		1 583	77	31 853	30 324	384 304
1956	342,553	26 926		8 308	82	36 683	38 113	452 665
1957	377 655	28 365		555	80	41 475	39 818	487 948
1958 P	386 094	32 655			147	43,708	43 963	506 557
Alaskan Airlines[2]								
1939								
1949	2 188	2 122				547[3]	3 639	8 496
1955	8 162	2 333		5 618		2 464	3,747	22 324
1956	10 200	2 477		6 241		2 754	7 680	29 352
1957	11,263	2 662		6 369		2 651	4 063	27 008
1958 P	12 522	2 918		6 854		2 701	3 925	28 920
All-Cargo Airlines[2]								
1939								
1949						1 810	300	2 110
1958		60				18 640	8 335	27 035
1956		144	220		447	25 564	26 485	52 860
1957		189	263		545	29,281	55 050	85 328
1958 P		486	89		300	23,171	54 862	78 908
CONSOLIDATED INDUSTRY[1]								
1939	40,999	29 547				2 232[5]	2 823	75 601
1949	549,942	136 652			29 239	22 256	32,172	771 262
1955	1,363 579	53 644	2,859	34,317	28 247	93 893	66,441	1,634,939
1956	1,541,596	59 773	2,977	43,490	19,520	108,734	100,471	1,876,561
1957	1,731,497	63,614	3,128	41,396	16 119	125,143	134,533	2,115,429
1958 P [6]	1,826,344	78,634	3,281	45,958	17,441	129,949	144,870	2,237,469

P Preliminary

[1] Prior to October 1, 1953 public service revenues were not reported separately

[2] Local Service operations were initiated in 1945 Helicopter operations in 1947 and All Cargo airlines in the Fourth quarter of 1949 Data not available for Alaskan Airlines in 1939.

[3] Express and Freight revenues are combined for the Territorial and the Alaskan carriers They are reflected in freight totals

[4] Other revenues include revenues from excess baggage and from charter operations and incidental revenues

[5] Revenues included for Seaboard and Western are for the twelve months ended September 30, 1958

DISTRIBUTION OF OPERATING EXPENSES

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS HOW THE AIRLINES SPEND THEIR DOLLARS TO INSURE FAST, SAFE ECONOMICAL FLYING OPERATIONS AND EFFICIENT PASSENGER AND CARGO HANDLING

Explanation of New Classification of Operating Expenses

The classification of operating expenses is different from that used in prior years Owing to a revision of the form on which the carriers report to CAB it is not feasible to bring forward beyond 1956 the expense tables previously published in Facts and Figures For this reason the data shown herein for years prior to 1956 were recast for this publication into the format of the new reporting system—insofar as it was feasible to do so The data shown for 1957 and 1958 are as reported by the carriers Although the "matching" of prior years' data with 1957 and 1958 is not perfect, it is considered adequate for general use where precision is not required.

The classifications of expenses employed in past issues of "Facts and Figures" were grouped as follows to fit the new format:

NEW CLASSIFICATION	OLD CLASSIFICATION
Flying operations	Flying operations
Maintenance	Direct maintenance—flight equipment Ground and indirect maintenance
Passenger service	Passenger service
Aircraft and traffic servicing	Ground operations
Promotion and sales	Traffic and sales Advertising and publicity
General and administrative	General and administrative
Depreciation and amortization	Depreciation—flight equipment Depreciation—ground equipment

As pointed out above this method of matching accounts is not perfect. The figures for 1957 and 1958 differ in the following respects from those shown for 1956 and earlier.

1) "Amortization of other deferred charges" dispersed throughout the accounts for 1956 and before is grouped in "Depreciation and amortization" after 1956.

2) "Legal fees and expenses," dispersed in several accounts prior to 1957 is all in "General and administrative."

3) Payroll taxes and employee welfare insurance included in "General and administrative" before 1957 are distributed to other appropriate accounts.

4) Airport ticket office expenses included in "Promotion and Sales" for earlier years is under "Aircraft and Traffic Servicing."

5) Route extension and development expenses, not classified as operating expense in prior years are included in "Depreciation and Amortization," after 1956

	Flying Operations	Maintenance	General Services & Administration: Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G. S. & A.	Depreciation & Amortization	Total Operating Expenses
Domestic Trunk Airlines									
1939	15 682	8 191	1 844	8 934	6 205	4 011	20 994	5 667	50 941[2]
1949	119 961	83 674	27 778	66 623	59 195	30 894	184 490	47 033	435,157
1955	302 591	196 320	72 996	133 274	134 706	68 473	409 449	101 709	1 010,069
1956	340 670	239 530	83 953	152 928	159 366	79 462	475 709	106 321	1,162 230
1957	434 842	270 328	95 505	217 208	157 561	55 164	525 438	146 968	1 377 576
1958 P	436 953	285 564	101 361	230 846	165 772	58,182	556 161	139 808	1 418 486

See Footnotes at Bottom of Page 113

Distribution of Operating Expenses (continued)

	Flying Operations	Maintenance	General Services & Administration: Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G S & A	Depreciation & Amortization	Total Operating Expenses
Local Service Airlines									
1939[1]									
1949	6 336	4 537	825	3 743	2 405	1 792	8 765	2 233	21 871
1955	18 080	10 384	2 687	9,563	9 287	4 485	26 022	2 278	56 764
1956	21 616	12 610	3 385	11 187	11 399	5 362	31 353	2 714	68 293
1957	26 609	16 418	4,028	21 160	6 089	4 938	36 218	3 758	82,900
1958[p]	29 265	18 686	4 527	24,023	6 998	5 530	41 078	4,274	93 303
Territorial Airlines									
1939	127	90	1	38	34	65	138	96	451
1949	1 091	900	165	922	628	682	2 397	444	4 832
1955	1 942	1 278	245	1 258	1 045	964	3 512	603	7 335
1956	2 033	1,259	252	1 317	1,182	848	3 599	416	7 307
1957	2 212	1 422	278	1 521	1 265	868	3 932	515	8 081
1958[p]	2 502	1 699	414	1 672	1 283	1,025	4 394	659	9,254
Helicopter Airlines									
1939[1]									
1949	151	133		50	2	63	115	111	810
1955	614	871	21	425	180	393	1 019	451	2 955
1956	697	981	21	544	312	496	1 373	608	3 656
1957	1 108	1 381					1 765[2]	911	5 164
1958[p]	1 410	1 646					1 972[2]	948	5 976
International & Overseas Airlines									
1939									17 266[3]
1949	72 347	47 245	14 617	33 168	35 731	22 600	106 116	27 185	252 863
1955	108 501	58 975	26 773	46 990	61 980	31 291	167,034	31 094	365 604
1956	128 613	72 069	31 053	51 583	70 822	33 808	187 266	34 593	419 541
1957	142 944	72 326	32 819	67 187	70 902	24 631	195 239	80 359	460 868
1958[p]	154 912	79 904	35 527	72 550	75 802	24 878	211 138	50 694	496 648

See Footnotes at Bottom of Page 113

Distribution of Operating Expenses (continued)

	Flying Operations	Maintenance	General Services & Administration: Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G S & A	Depreciation & Amortization	Total Operating Expenses
Alaskan Airlines									
1939[1]									
1949	3 440	2 343	370	988	714	1,180	3 282	1 143	10,178
1955	7 191	5 273	773	2 701	1 593	1 819	6 586	1,120	21,706[4]
1956	9,959	5 744	984	3 702	1 831	1 894	8 391	1,364	27,166[4]
1957	8 669	6 215	854	2 779	1 042	853	10 065[4]	1 646	26 595
1958[p]	8 998	6 383	921	3 281	1 067	1 185	10,626[4]	1 914	27 921
All-Cargo Airlines									
1939[1]									
1949	966	367		206	453	215	874	74	2 281
1955	10 635	5 287	267	3 896	2 081	2 103	8 347	2 074	26 343
1956	21 677	11 662	1 614	6,353	3 883	3 454	15 304	3,185	53 879[4]
1957	36 563	18 969	3 618	12 450	4 064	4 395	25 203[4]	6 998	89 734
1958[p 4]	32 820	18 448	2 697	8 887	2 661	4 281	19 241[4]	9 445	79 954
CONSOLIDATED INDUSTRY									
1939[1]	15 809	8 281	1,345	8 972	6,239	4,076	21 132	5,761	68 658[5]
1949	204 292	139,199	43,755	105 700	99,127	57 426	306 008	78 493	727,692
1955	449 558	278 388	103,762	198 107	218 872	109 228	621,969	139 329	1,490 776[4]
1956	522,265	343,855	121 202	227,614	248 795	125,344	722,995	149,168	1,742,072[4]
1957	652 847	387,060	136 802	322 385	248 923	90,848	797,855[4]	213,156	2,050,918
1958[p 4]	666 860	412 330	145,447	341,259	253,503	95 051	844,610[4]	207,742	2,131,542

[1] Data not available for Alaskan airlines in 1939. All-Cargo airlines began certificated operations in fourth quarter of 1949. Local Service Operations initiated in 1945. Helicopter operations started in 1947.
[2] Colonial airlines included in the breakdown total for 1939 but not in the detail.
[3] Detailed expense data not available.
[4] Total is greater than sum of individual expense categories since segregation of expenses is not reported by some classes of carriers.
[5] Total for 1939 includes international carriers, not included in the detail. See note 3.
[6] Data included for Seaboard and Western are for the 12 months ended Sept. 30, 1958.
[p] Preliminary

SUMMARY OF PROFIT OR LOSS

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS THE EARNINGS OF AIRLINES WHICH WERE AVAILABLE FOR DIVIDENDS TO STOCKHOLDERS OR FOR RETENTION IN THE BUSINESS. IT ALSO SHOWS THESE DOLLARS AS A PER CENT OF SALES AND THE RATIO OF TOTAL RETURN TO INVESTMENT

	Total Operating Revenues	Total Operating Expenses	Net Operating Income	Interest on Long-Term Debt	Other Non Operating Income (Net)	Income Taxes	Net Profit or Loss[2]	Rate of Return on Investment[3] (%)	Profit Margin on Sales[4] (%)
Domestic Trunk Airlines									
1939	55 527	50 941	4 586	n.a	n.a.	n.a.	n.a		
1949	459 783	435 157	24 626	4 466	803	7 285	13 378		
1955	1 133 348	1 010 069	123,279	6 540	16 388	70 024	63 103	11.8	5 6
1956	1 262 831	1 162 230	100 601	9 964	23 917	56 842	57 712	9 4	4 6
1957	1 419 614	1,377,576	42 036	16 201	18 651	23 076	26 988	4 9	1 9
1958 [P]	1 513 019	1 418 486	94 533	24 309	19 859	43 842	44 709	6 6	3 0
Local Service Airlines [1]									
1939									
1949	21 418	21 871	(453)	80	(749)	168	(1 451)		
1955	57 450	56 764	686	219	369	484	352	2 7	0 6
1956	67 712	68 293	(581)	376	106	(50)	(801)	(—)	(—)
1957	82 139	82 900	(760)	224	(472)	(51)	(1 153)	(—)	(—)
1958 [P]	94 654	93 303	1 351	824	282	348	2 306	15 5	2 4
Territorial Airlines									
1939	421	451	(30)	n.a	n.a.	n.a.	n.a		
1949	4 778	4,832	(54)	9	(69)	87	(189)		
1955	7,114	7 335	(221)	106	210	8	(125)	(—)	(—)
1956	7 430	7 307	123	97	(14)	—	12	3.3	0.2
1957	8 360	8 081	278	109	376	83	267	11 0	3 2
1958 [P]	9 396	9,254	142	163	(48)	1	(70)	4 3	(—)
Helicopter Airlines [1]									
1939									
1949	822	510	12	—	(28)	—	(16)		
1955	3 355	2 955	400	11	155	202	342	10 0	10 2
1956	3 711	3 656	55	23	(63)	8	(39)	(—)	(—)
1957	5 032	5,164	(131)	64	19	(55)	(111)	(—)	(—)
1958 [P]	6 015	5 976	39	96	19	(8)	(30)	1 3	(—)

See Footnotes at Bottom of Page 115

Summary of Profit or Loss
(continued)

	Total Operating Revenues	Total Operating Expenses	Net Operating Income	Interest on Long Term Debt	Other Non Operating Income (Net)	Income Taxes	Net Profit or Loss[2]	Rate of Return on Investment[3] (%)	Profit Margin on Sales[4] (%)
International and Overseas Airlines									
1939	19 653	17 266	2 387	n a	n.a.	n.a	n a		
1949	274 155	252 863	21 292	736	(11 740)	1 362	7,454		
1955	384 304	365 604	18 700	1,700	6 754	10 320	13,434	6 3	3 5
1956	452 665	419 541	33 124	3 000	8 169	17 792	20 501	8 2	4 5
1957	487 665	419 541	33 124	3 000	8,619	13 282	19 520	7 8	4 0
1958 [P]	506 557	496 648	9 909	5,792	7 300	5 441	6,793	3 7	1 3
Alaskan Airlines [1]									
1939									
1949	8 496	10 178	(1 682)	38	(97)	28	(1,789)		
1955	22 324	21 706	518	76	228	334	436	8 3	2.0
1956	29 352	27,166	2 186	222	(98)	870	996	15 1	3 4
1957	27 008	26 595	413	362	729	121	900	11.1	3 3
1958 [P]	28 920	27 921	999	415	355	631	882	9.6	3 0
All-Cargo Airlines [1]									
1939									
1949	2 110	2 281	(171)	—	18	2	(155)		
1955	27 035	26 343	692	561	1 132	80	1 163	9 4	4 4
1956	52 860	53,879	(1,019)	488	4 539	1 210	1 822	7 0	3 4
1957	85 328	89 734	(4 406)	1 526	4 022	285	(2 207)	(—)	(—)
1958 [P]	78 908	79 954	(1 046)	1 669	(212)	2 335	(1,676)	(—)	(—)
CONSOLIDATED INDUSTRY									
1939	75,681	68,658	6,943	n.a.	n a	n a	n.a.	—	—
1949	771,262	727,692	43,570	5 329	(12,188)	8 902	17 235	—	—
1955	1,634,933	1,490,776	144,154	9,213	25,236	81,452	78 725	10 8	4 8
1956	1,876,561	1,742 072	134 489	14 170	36,556	76,672	30,203	8 8	4 3
1957	2,115,429	2,050,918	64,511	23,368	31,665	36,683	44 202	5 1	2 1
1958 [P] [5]	2,237 469	2,131,542	105 927	33,268	27,555	52,598	52,914	5 8	2 4

n.a Not Available

[1] Data not available for Alaskan airlines in 1939. All Cargo airlines began operations in fourth quarter of 1949. Local Service operations initiated in 1945. Helicopter operations started in 1947.

[2] Net profit or loss for 1957 and 1958 is shown after "Special Items," which are not included in the detail. Therefore, the items do not add to the profit figures shown.

[3] Net income before interest and after taxes as percent of average net worth and long term debt.

[4] Profit as percent of revenues.

[5] Data for Seaboard and Western are for the 12 months ended Sept. 30 1958.

[P] Preliminary.

ASSETS, LIABILITIES AND STOCKHOLDERS' EQUITY

U. S. Scheduled Airline Industry

(As of Dec. 31, for Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS WHAT THE SCHEDULED AIRLINES OWN AND WHAT THEY OWE

	1939	1948	1955	1956	1957	(Sept. 30) 1958
Domestic Trunk Airlines[b]						
Assets						
Current Assets	23,592	178 471	436 609	439 827	457 611	456 748
Investments and Special Funds	2 565	41 370	47 405	146,147	127 943	163 496
Flight Equipment		329 915	890 095	1,097 044	1 363 767	1,489 783
Reserve for Depreciation and Maintenance		141 296	478 482	553 793	639 019	719 249
Ground Property and Equipment	17,412a	91 837	154 104	180 613	206 452	223 809
Reserve for Depreciation		35 271	77 622	89 217	101 001	112 489
Other Property		7 618	28 402	41 359	49 667	77 549
Deferred Charges	1 754	15 658	9 459	13 264	23 641	28,247
Other Assets	708	1 640	1,175	6 308		
Total Assets	46 051	486 942	1 011 145	1 281 552	1 488 961	1 607 894
Liabilities and Equity						
Current Liabilities	9 316	98 428	276 839	333 876	328 844	322,098
Long-Term Debt	4 002	148 017	198 916	324 071	469 486	834 644
Other Non-Current Liabilities					1 224	19 582
Operating Reserves	257	3 636	8 368	10,490		
Deferred Credits	721	12 724	22 886	37 646	81 480	78 288
Stockholders' Equity—Net of Treasury Stock	31,755	224,137	504 139	575 469	637 927	656 282
Preferred Stock	621	60 827	29 789	16 592	15 805	14 434
Common Stock	21,385	62 884	80 172	88 555	108 502	109 896
Other Paid-In Capital	12 903	63 434	141 839	178 058	215 292	221 383
Retained Earnings	(3 154)	36 992	252 339	291 872	298 328	310 569
Total Liabilities and Equity	46 051	486 942	1 011 145	1,281 552	1 488 961	1 607 894
Local Service Airlines						
Assets						
Current Assets		5 648	12 970	14 873	16 512	17 522
Investments and Special Funds		684	950	1 438	3 028	3 358
Flight Equipment		7 926	21 451	26 105	32 949	37 335
Reserve for Depreciation and Maintenance		3 780	11 096	12 628	16 825	19 202
Ground Property and Equipment		2 242	5 122	5 795	6 544	7 035
Reserve for Depreciation		869	2 555	2 949	3 556	4 080
Other Property		321	682	3 692	607	1 620
Deferred Charges		2 007	885	1,564	1,931	2,141
Other Assets		75	2	35		
Total Assets		14 254	28 411	37 925	41,190	45 729
Liabilities and Equity						
Current Liabilities		4 449	12 461	17,431	22 002	23 627
Long-Term Debt		1 578	4 013	7 800	8 656	9 733
Other Non-Current Liabilities					205	349
Operating Reserves		170	783	1 138		
Deferred Credits		100	21	303	264	198
Stockholders' Equity—Net of Treasury Stock		7 957	11 133	11 253	10 063	11,822
Preferred Stock		226	412	920	163	163
Common Stock		5 191	6,345	8 871	6 776	7,359
Other Paid In Capital		4,265	4 324	4 891	4 863	5 669
Retained Earnings		(1,725)	52	(429)	(1 739)	(1,369)
Total Liabilities and Equity		14 264	28,411	37,925	41 190	45,729

a. Net property and equipment
b Balance sheet data for domestic trunk airlines reflect their international as well as domestic operations

Assets, Liabilities and Stockholders' Equity *(continued)*

	1939	1949	1955	1956	1957	(Sept. 30) 1958
Territorial Airlines						
Assets						
Current Assets	100	1 333	1,068	1,241	1,964	2,246
Investments and Special Funds	72	272	19	15	113	21
Flight Equipment		2 220	5 744	6 057	8 932	7 751
Reserve for Depreciation and Maintenance		1,331	2 839	2 930	3 230	3,646
Ground Property and Equipment	333a	963	1 177	1 276	1,354	1,481
Reserve for Depreciation		528	749	847	945	1,025
Other Property		132	41	17	133	59
Deferred Charges	38	156	180	169	182	358
Other Assets		25				
Total Assets	543	3,242	4,641	4,998	5,503	7,248
Liabilities and Equity						
Current Liabilities	18	763	1 329	1 520	2 011	2 399
Long Term Debt	52		1 835	1 702	1,635	2 758
Other Non Current Liabilities						
Operating Reserves	15	10	20	41		
Deferred Credits		81	1	68	23	17
Stockholders Equity—Net of Treasury Stock	448	2,388	1,456	1,667	1,834	2 071
Preferred Stock						
Common Stock	448	2 649	1,981	1,981	1 981	1 981
Other Paid In Capital	9	132	874	832	832	832
Retained Earnings	(9)	(393)	(1,399)	(1 146)	(979)	(742)
Total Liabilities and Equity	543	3,242	4,641	4,998	5 503	7,245
Helicopter Airlines						
Assets						
Current Assets		†	14	71	1	32
Investments and Special Funds		138	163	196	302	803
Flight Equipment		59				
Reserve for Depreciation and Maintenance		723	4 253	5 476	5 798	6 551
Ground Property and Equipment		174	2 385	2 307	2 168	2 119
Reserve for Depreciation			321	290	27	82
Other Property		486	2 508	3 878	5 170	4 848
Deferred Charges		165	1,313	1 645	2 336	1,428
Other Assets		42	312	576	777	796
Total Assets		12	137	197	311	371
Liabilities and Equity						
Current Liabilities		69	591	735	961	1 264
Long Term Debt			87	817	1 033	1,467
Other Non-Current Liabilities						1
Operating Reserves			31	45		
Deferred Credits			25	69	109	115
Stockholders' Equity—Net of Treasury Stock		654	3,819	3,810	3,695	3,704
Preferred Stock		320				
Common Stock		375	677	702	734	771
Other Paid-In Capital			2 201	2,435	2 546	2 685
Retained Earnings		(41)	641	673	415	248
Total Liabilities and Equity		723	4,253	5 476	5 798	6,551
International and Overseas Airlines[b]						
Assets						
Current Assets	7,913	68 903	109 019	111 560	102 202	109 329
Investments and Special Funds	790	8 448	33 230	37 987	52 992	80,446
Flight Equipment		143 009	216 737	265 785	276 758	280 461
Reserve for Depreciation and Maintenance		46 837	99 787	114 074	132 185	146 385
Ground Property and Equipment	16 839a	22 649	29 595	31 813	34 351	35 278
Reserve for Depreciation		10 730	18 424	18 614	20 741	22 396
Other Property		2,536	2 719	2 450	4,239	7,095
Deferred Charges	327	25 276	3,766	4 440	4,413	6,193
Other Assets	4,486					
Total Assets	30 355	213,254	276,855	321 347	322 029	350,021

(International and Overseas Airlines continued on next page)

See Footnotes at Bottom of Page 116

Assets, Liabilities and Stockholders' Equity (continued)

	1939	1949	1955	1956	1957	(Sept 30) 1958
International and Overseas Airlines						
Liabilities and Equity						
Current Liabilities	6 169	32 483	90,041	92 352	87,424	106 621
Long-Term Debt	2,115	43,307	60,481	83,406	85,653	92 688
Other Non-Current Liabilities	767				1,011	880
Operating Reserves		5 333	3 319	3 584		
Deferred Credits	527	18 407	8 846	6 058	6 648	7,123
Stockholders' Equity—Net of Treasury Stock	20 777	113,724	127 168	135 947	141 293	142 709
Preferred Stock		150	150			
Common Stock	7 060	12 755	13 622	13,792	16 310	16,346
Other Paid-In Capital	10 458	77 883	63 120	63 460	62 129	62 420
Total Retained Earnings	3 259	22 936	50 276	59,119	62 854	63 943
Total Liabilities and Equity	30 355	213,254	276 855	321 347	322 029	350 021
Alaskan Airlines						
Assets						
Current Assets		2 408	5 600	7 129	7 682	8 819
Investments and Special Funds		5	248	532	957	885
Flight Equipment		4,431	6 906	11,126	13 658	15 243
Reserve for Depreciation and Maintenance		2 483	4 981	5 539	6 080	6 847
Ground Property and Equipment		1 407	3,808	4 201	4 843	4,877
Reserve for Depreciation		544	1 531	1 808	2 138	2 335
Other Property		207	163	400	313	1,102
Deferred Charges		348	358	422	624	774
Other Assets		214	136	134		
Total Assets		8,993	10,709	16,597	19,869	22,518
Liabilities and Equity						
Current Liabilities		2,530	4,002	6 170	7 084	7,939
Long-Term Debt		491	765	3 360	4 942	8 938
Other Non-Current Liabilities					28	42
Operating Reserves		141	457	276		
Deferred Credits		65	200	42	104	209
Stockholders' Equity—Net of Treasury Stock		2,766	5 285	6,749	7,714	8 390
Preferred Stock		7				279
Common Stock		2 151	2 950	3,182	3,315	3 497
Other Paid-In Capital		2 917	3 605	3 613	3 629	3 622
Retained Earnings		(2 309)	(1,270)	(16)	770	992
Total Liabilities and Equity		5,993	10,709	16 597	19 869	22,518
All-Cargo Airlines						
Assets						
Current Assets		2 600	11 716	21 224	19 689	22,881
Investments and Special Funds		53	2 850	17 244	4 629	3 714
Flight Equipment		2 293	24,143	31 540	65 449	89 989
Reserve for Depreciation and Maintenance		589	7 575	9 198	17 500	18 743
Ground Property and Equipment		969	2 753	4 666	5 579	5 294
Reserve for Depreciation		467	1,354	1 833	2 382	2 484
Other Property		23	399	3 028	2,682	2 879
Deferred Charges		365	410	2 706	8,122	4,940
Other Assets			140	281		
Total Assets		8 247	33,482	69,668	83,167	78,170
Liabilities and Equity						
Current Liabilities		1,568	10 759	19 301	25 991	22 153
Long-Term Debt		1,431	7,598	16 813	28 121	23,100
Other Non-Current Liabilities					449	1,312
Operating Reserves		101	1,808	2 311		
Deferred Credits		17	235	2 277	3 257	3 998
Stockholders' Equity—Net of Treasury Stock		2,130	13,082	28 966	28 349	27 607
Preferred Stock			1 211	1 441	1 437	1 436
Common Stock		4,169	5 466	6 863	8 237	8 532
Other Paid-In Capital		3 135	4,304	14 341	15 701	17 649
Retained Earnings		(5 174	2 101	6 321	2 974	(10)
Total Liabilities and Equity		5,247	33,482	69 668	83,167	78,170

See Footnotes at Bottom of Page 116

Assets, Liabilities and Stockholders' Equity (continued)

	1939	1949	1955	1956	1957	(Sept 30) 1958
Consolidated Industry						
Assets						
Current Assets	31,605	256,537	579,367	598 161	607 728	619 364
Investments and Special Funds	3,447	50,832	85,023	203,653	189 689	251 972
Flight Equipment		490,280	1,162 594	1,441 535	1,763,693	1,895 410
Reserve for Depreciation and Maintenance	34,584c	196 661	606,073	699 797	817 175	915 500
Ground Property and Equipment		120 109	196 971	228 940	259 899	278,570
Reserve for Depreciation		48 421	102 372	115,465	138 074	145,180
Other Property		10,838	32 420	51,817	57,642	90,336
Deferred Charges	2,119	43 948	15 221	22,761	36,115	43,156
Other Assets	5,194	2,013	1,455	6 758		
Total Assets	76,949	729,655	1,369,496	1,737,563	1,966,517	2,118,128
Liabilities and Equity						
Current Liabilities	15,503	160,290	366 922	471 395	474,317	496 101
Long-Term Debt	6,179	194 834	273,695	437,969	596 526	670,328
Other Non-Current Liabilities	767				2,914	22,166
Operating Reserves	272	9,391	14,783	17,885		
Deferred Credits	1,248	31,394	29,214	46 463	61 885	86 966
Stockholders' Equity—Net of Treasury Stock	52,980	333 756	665,782	763,861	830 675	852 585
Preferred Stock	631	61,530	31 563	18,953	17,405	16 312
Common Stock	28,893	90,174	111,213	120,916	145 855	148 382
Other Paid In Capital	23,370	151,766	220,267	267,630	304,992	314,260
Retained Earnings	96	30,266	302,740	356 394	362,633	373,631
Total Liabilities and Equity	76,949	729,655	1,369,496	1,737,563	1,966,517	2,118,128

See Footnotes at Bottom of Page 24

DOMESTIC INTERCITY PASSENGER MILES

(For Selected Years, In Millions)

	1939	1949	1955	1956	1957	1958
Railroad Travel[1]						
First Class	7 827	9 349	6,440	6 275	8,185	4 249
Coach	11 180	20 310	17 329	17,105	16 365	14 300[r]
Air Travel[2]						
First Class	654	6 454	13 025	14 202	15 736	15 180
Coach		251	6 716	8 074	9 510	10 076
Motor Bus Travel[3]	9 100	22 411	16 562	16 409	14,886	14 588[r]
Total Common Carriers	28 461	58 775	60 072	62 065	61 682	58 393
Airline Share of Total	2 3	11.4	32 9	35 9	40 9	43 3
Private Automobile, Intercity[4]	234 700	376 313	585 800	617,700	637 800	680 000[5]
Total Common Carrier and Auto	263 161	435 088	645 872	679 765	699 482	708 393
Airline Share of Total Interrity Travel	0.2	1.5	3.1	3.3	3.6	3.6

[1] I.C.C. Statistics of Railways in the United States, 1958 Statement M-250.
[2] 1939, CAB Annual Airline Statistics. 1949 CAB Recurrent Reports on Traffic Statistics. 1955-1957 CAB Monthly Reports on Air Carrier Traffic. 1958 Carrier Reports to CAB.
[3] 1939 I.C.C. Statement No. 531. Jan. 1953; 1949-1957 I.C.C. Transport Economics, Dec. 1958.
[4] 1939 NAMBO Bus Facts 20th Edition, 1949-1956, I.C.C. Transport Economics May 1956. 1958 estimated on basis of gasoline sales.
[r] Estimated.

REVENUE PASSENGERS CARRIED

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Passengers)

	1939	1949	1951	1952	1953	1954	1955	1956	1957[2]	1958[2]
Domestic Trunk Airlines	1,713	14 021	20 621	22 759	26,137	29 526	34,511	37 598	40 270	39,513
Local Service Airlines		678	1 481	1 736	2 032	2 423	2 897	3 453	3 943	4 265
Territorial Airlines	22	382	850	515	553	561	591	627	589	572
Helicopter Airlines	---	---	---	---	1	9	29	62	148	228
International and Overseas Airlines	129	1 520	2 038	2 362	2 682	2 888	3 376	3 888	4 065	4,182
Alaskan Airlines[1]	n.a.	122	157	194	220	225	264	315	309	315
TOTAL SCHEDULED AIRLINE INDUSTRY	1,864	16,723	24,847	27,566	31,625	35,632	41 623	45 943	49 839	49,075
AVERAGE LENGTH OF HAUL (Statute Miles)										
Domestic Trunk Airlines	397	469	495	533	547	550	557	576	608	618
International and Overseas Airlines	587	1 351	1 275	1 278	1 261	1,296	1,307	1 315	1,415	1,429

[1] Alaskan data for 1949 include charter flights. 1939 not available.

[2] Passengers for 1957 and 1958 were reported on a basis which yielded slightly lower figures than the basis used in prior years. This accounts in part for the typical increase of average length of haul in 1957 as compared to 1956.

AVERAGE REVENUE PER PASSENGER MILE

Intercity Common Carriers

(For Selected Years, In Cents per Mile)

	1939	1946	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Domestic Scheduled Airlines[1]												
Coach or Tourist			3 96	4 10	4 45	4 18	4 13	4 34	4 32	4.29	4.25	4.52
All Services	5 28	4 62	5 75	8 54	5.59	5 54	5 43	5 37	5 32	5 28	5 25	5 58
International Scheduled Airlines												
Coach or Tourist	---	---	---	---	---	---	8 77	5 83	n.a.	n.a.	5 77	5 66
All Services	8 57	8 31	7 72	7 28	7.13	7 04	6 88	6 79	6 68	6 70	6 57	6.52
Railroads, Class I[4]												
First Class[3]	2 33	2 45	3 14	3 25	3.27	3 35	3 38	3.35	3 31	3 39	3 68	3 72
Coach	1 80	1.82	2 41	2 47	2 47	2 53	2.53	2 50	2 47	2 56	2 71	2 75
Intercity Motor Buses, Class I	1 56	1 66	1 84	1 88	1 94	2 02	2 05	2 07	2 05	2 13	2 26	2 37[2]

[1] Trunk airlines

[2] Estimated

[3] Does not include payments to Pullman Company for seat, berth, etc.

[4] Excludes commutation.

n.a. Not available

Note: Average passenger fare is derived by dividing passenger revenue by revenue passenger miles.

AIRCRAFT OWNED AND ON ORDER

By U. S. Scheduled Airline Industry

(For Selected Years)

THIS TABLE SHOWS HOW THE SIZE AND TYPE OF AIRCRAFT USED BY THE SCHEDULED AIRLINES HAS IMPROVED OVER THE YEARS AND HOW THE SCHEDULED AIRLINES WILL CONTINUE TO ADD NEW AND FASTER AIRCRAFT TO INSURE IMPROVED SERVICE FOR THEIR CUSTOMERS

Manufacturer	Model	1939	1949	1952	1956	(Jan.)[1] 1959	New aircraft on order for delivery in: 1959	1960	1961
Boeing:	247D 307B, 314	45	5	---	---	---	---	---	---
	377	---	35	44	34	32	---	---	---
	B707 (Jet)	---	---	---	---	9	36	10	---
	8707-Intercontinental (Jet)	---	---	---	---	---	12	23	---
	B720 (Jet)	---	---	---	---	---	---	26	10
Convair:	240	---	112	113	100	76	---	---	---
	340	---	---	8	123	113	---	---	---
	440	---	---	---	19	31	---	---	---
	600 (Jet)	---	---	---	---	---	---	---	25[2]
	880 (Jet)	---	---	---	---	---	2	38	10
Curtiss:	C-46	---	2	75	94	87	---	---	---
Douglas:	DC-2	56	---	---	---	---	---	---	---
	DC-3	147	449	419	356	331	---	---	---
	DC 4	---	230	185	143	95	---	---	---
	DC 6	---	109	195	299	364	---	---	---
	DC 7	---	---	---	132	252	---	---	---
	DC-8 (Jet)	---	---	---	---	---	19	67	15
Fairchild:	F-27 (Turboprop)	---	---	---	---	21	18	---	---
Lockheed:	L 10	41	6	---	---	---	---	---	---
	Lodester	---	11	11	10	7	---	---	---
	Other early models	6	---	---	---	---	---	---	---
	Constellation	---	79	118	117	112	---	---	---
	Super Constellation	---	---	24	79	140	---	---	---
	Electra (Turboprop)	---	---	---	---	11	89	26	---
Martin:	202	---	24	21	23	26	---	---	---
	404	---	---	96	97	95	---	---	---
Sikorsky:	All types	28	---	---	---	---	---	---	---
Vickers:	V 700 (Series) (Turboprop)	---	---	---	54	70	---	---	---
	V 800 (Series) (Turboprop)	---	---	---	---	12	3	---	---
Other		24	10	17	25	18	---	---	---
Total Fixed Wing		347	1 072	1,323	1,705	1,902	179	190	60
Helicopters:									
Bell	B47	---	6	6	7	4	---	---	---
Sikorsky	S51	---	5	3	2	2	---	---	---
	S55	---	---	5	8	6	---	---	---
	S58	---	---	---	3	5	---	---	---
	V44B	---	---	---	---	5	---	---	---
Total Helicopters		---	11	14	20	22	---	---	

[1] Piston powered aircraft data are as of January 14 and turbine as of January 31, 1959.

[2] Ten scheduled for delivery in 1961 and 15 in 1962.

COMPARATIVE TRANSPORT SAFETY RECORD

Passenger Fatality Rate per 100,000,000 Passenger Miles (For Selected Years)

	1939	1949	1951	1952	1953	1954	1955	1956	1957	1958
Domestic Scheduled Airlines										
Fatalities	9	93	142	46	86	16	156	143	30	113
Rate	1 20	1 39	1 35	.37	.59	.10	.79	.64	.12	.45
International and Overseas Scheduled Airlines [1]										
Fatalities	10	4	43	94	2	0	2	9	40	11
Rate	12 80	.19	1 59	2 98	.06	.....	04	.17	67	.18
Motor Buses										
Fatalities	[2]	120	130	100	70	60	100	80	70	n.a.
Rate	[2]	.19	22	.16	.13	.11	.19	.16	.13	n.a.
Railroad Passenger Trains										
Fatalities	32	29	180	14	50	23	19	57	17	61 [3]
Rate	14	08	.43	04	16	08	07	.20	07	26 [3]
Passenger Autos and Taxis										
Fatalities	16 300	15 300	21 000	22 600	23 500	22,500	24 700	26 100	25 700	n.a.
Rate	3 7	2 0	2 4	2 8	2 9	2.6	2 7	2 7	2.6	n.a.

[1] Alaska data not included in 1939.
[2] Motor Bus statistics included in Passenger Autos and Taxis.
[3] Preliminary
n.a. Not Available

COMPARISON OF RAIL AND AIR FARES WITH TRAVEL TIMES

(1949 and 1958)

FARES

	First Class						Coach					
	Rail [a]			Air			Rail			Air		
	1949	1958	% Change	1949	1958	% Change	1949	1958	% Change	1949	1958	% Change
Chicago—New York	$ 39 55	$ 74 35 [b]	88 0	$ 44 10	$ 47 95	8 7	$22 75	$37 33	64.1	$29 60	$ 34 10	15.2
Detroit—Boston	32 54	51 21 [b]	57 4	38 70	42 30	9.3	19 88	31 03	56.1		32 35	
Los Angeles—New York	132 90	163 50	23 0	157 85	166 25	5 3	71 42	92 91	30.1		104.00	
Washington—New Orleans	49 73	61 59	23 8	62.95	67.55	7.3	28 32	34.49	21.8	45 70	45 00	—1 5
Dallas—San Francisco	79 56	91 06	14 5	96 35	102 85	6 7	42 88	50 65	18 1		70.70	
Minneapolis—Seattle	76 56	87 84	14.7	97.25	103 20	6 1	43 45	47 90	10.2		75 75	
Cincinnati—Miami	51 66	64 95	25 7	62 50	68 10	9 0	29 29	36 46	24 5		42 98	
Philadelphia—Atlanta	35 19	47 83	35 9	44.25	48 10	8 7	20 00	24 92	24 6		30 35	

TRAVEL TIMES

	Rail			Air		
	1949	1958	% Change	1949	1958	% Change
Chicago—New York	15 30	15.30	0.0	2 55	2 25	—17.1
Detroit—Boston	14 50	13 35	—8 4	3.10	2 35	—18 6
Los Angeles—New York	66 00	63 50	—3 3	9:45	7:20	—24 8
Washington—New Orleans	27 00	25 20	—6.2	3:15	3 05	— 5.2
Dallas—San Francisco	47 10	44 15	—6 9	5:20	4 48	—10 9
Minneapolis—Seattle	37 15	36:10	—2 9	7:25	5:20	—28.2
Cincinnati—Miami	33:05	31:45	—4 0	6:18	3 12	—49 2
Philadelphia—Atlanta	15 47	15 08	—4 1	5:26	2 58	—45 3

[a] Includes price of a lower berth.
[b] Roomettes substituted for lower berth, when no berth charge is shown on timetable

CLASSES OF UNITED STATES COMMERCIAL AIR CARRIERS

At the end of 1958 there were seven recognized classes of air carriers in the air transport industry of the United States. These classifications are used by the Civil Aeronautics Board in connection with the economic regulation of the industry and under the Civil Aeronautics Act are based largely on the scope of operations authorized or allowed by that Act. Classes One to Six have certificates of convenience and necessity and conduct regularly scheduled services.

1. The Domestic Trunk Lines include those carriers which presently have permanent operating rights within the continental United States. There are currently twelve trunk lines, most of which operate high-density traffic routes between the principal traffic centers of the United States.

American	Continental	National	Trans World
Braniff	Delta	Northeast	United
Capital	Eastern	Northwest	Western

2. The Domestic Local Service Lines have, with one exception, been certificated since 1945. These carriers operate routes of lesser traffic density between the smaller traffic centers and between these centers and principal centers. The thirteen local service lines in 1958 were:

Allegheny	Lake Central	Ozark	Southern
Bonanza	Mohawk	Pacific	Trans Texas
Central	North Central	Piedmont	West Coast
Fronner			

3. The International and Overseas Lines include all U. S. flag air carriers operating between the United States and foreign countries other than Canada. Some of these carriers conduct operations between foreign countries and some are extensions of domestic trunk lines into Mexico and the Caribbean.

Alaska	Eastern	Pan American	Trans Caribbean [2]
American	Mackey [2]	Pan American Grace	Trans World
Braniff	National	Resnit [1 2]	U. M. C. A. [2]
Caribbean Atlantic	Northwest	Samoan [2 3]	United
Delta	Pacific Northern	South Pacific [2 3]	Western

4. The Territorial Lines include two groups of carriers. The Insular Lines operate in the Hawaiian Islands and the Alaskan Lines operate between the U. S. and Alaska and within Alaska.

INSULAR LINES	ALASKAN LINES			
	Operating between the U. S. and Alaska		Operators within Alaska	
Hawaiian	Alaska [4]	Pacific Northern [4]	Alaska	Howard J. Mays [2]
Aloha	Northwest [6]	Pan American [5]	Alaska Coastal	Northern Consolidated
			Bristol Bay [2 3]	Pacific Northern
			Cordova	Pan American
			Ellis	Reeve Aleutian
				Wien

5. The Helicopter Airmail Lines presently operate between airports, central post offices, and suburbs of New York, Chicago and Los Angeles. Originally certificated as exclusive mail carriers they now fly passengers, air freight and air express.

Chicago Helicopter Airways	Los Angeles Airways	New York Airways

6. The All-Cargo Lines operate under temporary certificates authorizing scheduled cargo flights between designated areas in the U. S. and in one case to the Caribbean and in another to Europe.

AAXICO	Flying Tigers	Seaboard & Western
Aerovias Sud Americana	Riddle	Slick

7. Non-Certificated Air Carriers include a diversified group of operators who, with the exception of the air taxi operators and air freight forwarders, are not authorized to engage in regularly scheduled service. They are described in the CAB 1954 Annual Report as follows:

> Operators of various types of air services have been authorized by the Board through the exemption process, rather than through the requirement that a certificate of convenience and necessity be obtained. As of December 31, 1958 this group includes:

Supplemental and irregular transport carriers	43
Air freight forwarders	71
Air taxi operators	2019

[1] Certificated cruise carrier.
[2] Certificated non mail carriers.
[1 2 3] Statistical data of these carriers are not included in the statistical tables.
[3] Not operating.
[4] Statistical data of these carriers are included with Alaskan Airlines.
[5] Statistical data of these carriers are included with International and Overseas Airlines.

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20TH EDITION
Facts and Figures, 1959

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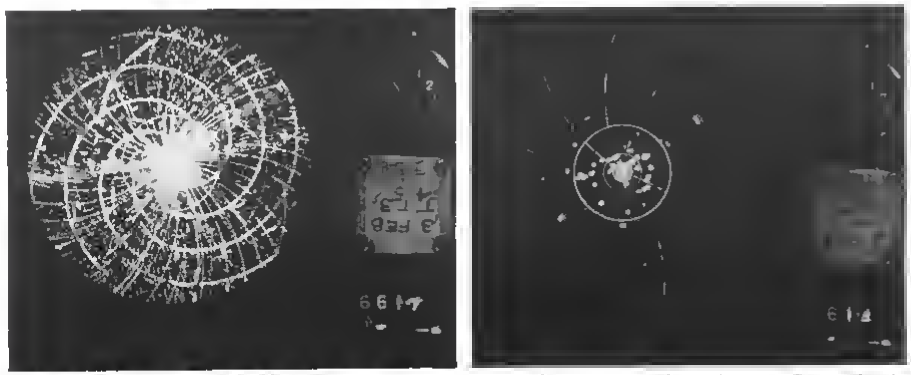


CLUTTERED display at left shows "fruit" resulting from reception of unsynchronized responses of airborne beacons to interrogations by other ATC radar beacon ground stations. Spiraling lines are caused by interference from nearby radars. Effectiveness of defruiting equipment is shown at right in scope photograph taken a few seconds later. There are 38 aircraft on the scope. Defruiting equipment uses dynamic storage properties of a quartz delay line to compare replies to successive interrogations in coincidence mixer.

FAA Will Operate Civil Beacon System

By James A. Fusca

New York—Nine ground installations of the Air Traffic Control radar beacon system will be transferred from experimental to operational status by the Federal Aviation Agency this summer. The decision is based on the preliminary results of a recently-concluded five month evaluation conducted jointly by FAA and the Air Force's Rome Air Development Center.

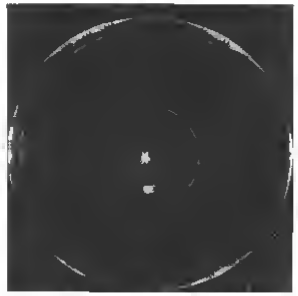
These early findings indicate that much safer and more effective control of both civil and military aircraft in areas of high traffic density and under adverse weather conditions will result from implementation of the ATC radar beacon system. The four ground stations in the New York area are to be commissioned in July, the remaining five, in Chicago, Washington, and Norfolk, by September. Civil aircraft presently equipped with the ATC radar beacon include all turbojet transports plus approximately 150 piston-engined aircraft.

Meets Requirements

An important conclusion of the study is that the civil radar beacon system meets the requirement of being operationally compatible for present and anticipated traffic densities with the military Identification Friend or Foe (IFF) beacon equipments of which there are more than 50,000 airborne units and more than 1,000 ground based units presently in use.

This compatibility means that both civil and military aircraft can operate with both civil and military air control and surveillance radars without it being necessary to carry two beacons in each aircraft.

The purpose of a secondary radar system such as the ATC beacon system is to overcome the limitations of primary radar systems now being used for air traffic control. Because primary radars depend upon the detection of the extremely small amount of radio energy reflected back to the radar from the target aircraft to establish its position, these systems are limited in that they cannot provide rapid target identification, they lose targets in the clutter on the operator's scope caused by poor weather or ground reflections, and they temporarily lose targets through inherent limitations of circuits designed to discriminate between moving and stationary objects.



DEFRUITED response of an airborne beacon replying in three pulse code is shown above. If decoders were employed, only desired codes would be displayed as single targets.

Both the civil ATC beacon system and the military IFF beacon system function in approximately the same manner to avoid these limitations. Each system employs an airborne beacon or transponder that upon receiving a coded interrogation signal from the ground transmits a train of pulses which establishes the position of the transmitting aircraft and which can be coded to furnish aircraft identification and other information.

Present Use

The basic Mark X IFF equipment has been in use with the Air Force for about 10 years. The more than 100 Aircraft Control and Warning stations of the Air Defense Command within the United States are equipped with Mark X interrogators for identifying and controlling aircraft within their sectors. Because the civil ATC beacon is compatible with the Mark X system, these AC&W stations are able to interrogate and track beacon equipped civil aircraft at present.

This compatibility is the basis for the present Civil Air Carrier Jet Advisory Service, set up by the FAA in cooperation with the military to assist in providing the additional protection required by civil turbojet aircraft flying at high speeds at the same altitudes and along the same routes as military turbojet aircraft.

First recommendations were that civil turbojets should fly only under full positive control, but the facilities and personnel for adding this service to the present air route traffic control service simply are not available. A compromise solution has been reached whereby civil turbojets flying above 24,000 ft make use of the Civil Air Carrier Jet Radar Advisory Service provided by assignment of FAA controllers to about 30 AC&W sites along the jet route structure within the United States.

Because all civil turbojets carry the ATC beacon which responds to interrogations from the Mark X IFF system, the civil and military controllers are able to provide cooperatively advisory information to pilots to preserve adequate separation between both types of turbojet aircraft. Any military aircraft not equipped with the Mark X IFF working in the compatible mode must receive special permission to enter or cross these routes.

In addition to being required to carry the ATC radar beacon, the civil turbojet transports are required to fly under instrument flight rules from takeoff until they are under the control of the local approach controller at their destination.

System Compatibility

There has been general agreement on the need for radar beacons as an aid to air traffic control ever since World War II, but the several civil programs under way at the start of the Korean War were terminated. In 1953 the Joint Communications Electronics Committee of the Joint Chiefs of Staff proposed that the characteristics of the civil air traffic control beacon system be made compatible with the Mark X IFF system in line with the "common system" concept.

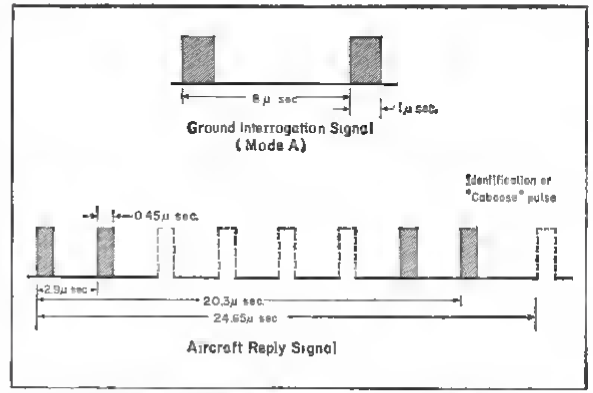
As could be predicted, there have been advantages and disadvantages to this approach. Because all interrogations are transmitted on 1,030 mc and all replies on 1,090 mc, the airborne transponder must reply to interrogations from all ground stations in its area—and there are more than 100 civil and military interrogators in the New York area—its transmitter must be protected by automatic overload control circuits from excessive power dissipation by limiting the interrogation duty cycle.

Also, the interrogator receiver hears not only the replies to its interrogations but the unsynchronized replies to the interrogations by all other ground stations in the area.

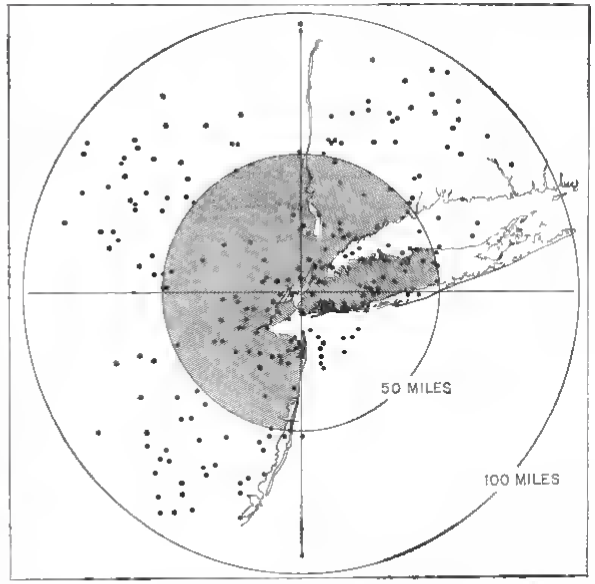
These unsynchronized replies create a type of interference clutter on the operator's scope known as "fruit" which, if not filtered out can make it extremely difficult to see the desired replies.

Certain other problems are created by the relatively low frequency of operation. For example, relatively large antennas are needed at the ground installations to obtain a high degree of directivity, these antennas must be sited on comparatively rough terrain or nulls appear in the vertical plane of the antenna beam, and the possibility exists of interference from other L-band navigational aids such as Tacan.

A related problem is that aircraft close enough to any ground station to receive interrogations from the side lobes of the ground antenna will reply and produce a "phantom" target on the oper-



TIMING of ground station interrogation signals and airborne beacon replies is shown above. Transponder is transmitting code 14. Identification pulse is transmitted only on request.



MAP of the New York area above shows estimated beacon-equipped air traffic within 100 mi. of New York for the year 1960, from a study for the FAA by Airborne Instrument Laboratory. Total of 234 aircraft are displayed.

ator's display. Several systems have been proposed and evaluated for solving the side lobe suppression problem but all require modification of the ground and airborne equipment and none is considered entirely satisfactory.

The five month evaluation program that ended last February was conducted jointly by the FAA and USAF's Rome Air Development Center for the purpose of determining the seriousness of present and anticipated problems where both secondary radar systems are operating together in an area of very high traffic density.

During the period of the tests, between 60 and 80 jet interceptors assigned to the Eastern Air Defense Force flew a series of test missions in the New York area in participation with 13 FAA experimental beacon-equipped aircraft. More than 100 of the ground-based interrogators in the area triggered the beacons of the civil and military aircraft to produce as much "fruit" on the controllers' displays as possible. The military aircraft participating included F-86Ls, F-89s, and F-102As.

One of the early conclusions of the tests was that the amount of "fruit" produced did not entirely disrupt control of traffic in the area. Whatever confusion resulted from the "fruit," however, could be eliminated by means of special "defruiting" equipment developed by the Naval Electronics Laboratory and Airborne Instrument Laboratory.

Interrogation Modes

The interrogation signals transmitted by the ground stations in both the civil ATC beacon system and the military Mark X IFF system consist of pairs of pulses, each pulse being one microsecond in length. Both systems have provisions for varying the mode of interrogation by varying the spacing between the pulses.

In the Mark X system, the purpose of having three modes of interrogation is for identification of the replying aircraft. In Mode 1, the Mark X interrogation signal pulses are three microseconds apart, in Mode 2 they are five microseconds apart and in Mode 3 they are eight microseconds apart.

Both ground and airborne equipments of the Mark X system can transmit one or more modes simultaneously or in sequence.

At present, only one mode of interrogation is planned for use with the civil ATC beacon—called Mode A. This mode has a pulse spacing of eight microseconds which makes it compatible with Mode 3 of the Mark X system. There are three other modes, however, that have been proposed for eventual use. These are Mode B with a pulse spacing of 17 microseconds, Mode C with a

spacing of 19 microseconds, and Mode D with a spacing of 23 microseconds.

Both ground and airborne equipment being produced now have provisions for being converted to employ more than the basic Mode A. Probably the first use of interlaced mode interrogation will be for requesting aircraft identification by Mode A and aircraft altitude by Mode B.

This interlaced operation would be by automatically alternating the pulse spacing of the interrogation signal so that the airborne beacon would first respond to Mode A and second to Mode B, with provisions for separating and decoding the replies in the ground equipment.

Looking farther into the future, thought is being given to employing Modes B, C, and D as automation modes—that is, as a form of ATC radar beacon and data link combined.

Airborne transponders in the direction of the main beam of a ground station interrogator—and, unfortunately, in the direction of side lobes as well—are interrogated by the Mode A pulses spaced eight microseconds apart. The transponders will reply up to an effective range of about 200 mi. After a delay of about three microseconds, each transponder replies with a pulse train code.

Each normal reply consists of a pair of framing or bracket pulses spaced about 20 microseconds apart. Between the framing pulses there are positions for six information pulses, each about one half microsecond in length.

The different possible combinations of the six information pulses make up a pulse train code system with a total of 64 possible codes available if all zeros and all ones are used. The reply code to be used is selected by the pilot on instructions from the ground controller.

The six binary bits transmitted by the existence or lack of a pulse in each of the information pulse positions are coded in two groups of three. Each group of three conveys in binary form the numbers one, two, and four. For this reason, although there are only a total of 64 codes, an octonary numbering system which transmits 00 through 77 is used to simplify the switching both in the air and on the ground.

In addition to transmitting the selected code, the transponder on signal from the pilot transmits for 15 sec. an identification pulse, called a "caboose pulse," about four microseconds after the normal pulse train which causes the appropriate target on the controller's display to bloom.

Civil turbojets presently are utilizing their ATC beacons to a limited degree. The Civil Air Carrier Jet Radar Advisory Service is employing only three of the 64 possible codes of the civil beacon. The reason is that many of the 30 AC&W sites cooperating have not yet received decoding equipment. Therefore the decoding must be done visually by the controller.

To enable the controller to distinguish between targets, the three codes in use appear as three, four, or five blips (codes 40, 42, and 62) close together in range.

Wherever possible civil aircraft are restricted to code 40 and military aircraft to code 62. Code 42 is used only when necessary to separate two civil aircraft because the four blips of the code closely resemble the four blip emergency signal of the Mark X military system.

Codes 00 and 77 may be reserved as special purpose codes. Under consideration is the use of code 00 to identify aircraft of the Air Defense Command and reservation of code 77 as an emergency signal to indicate an aircraft in distress.

The FAA has contracted for equipment to add a total of 55 new ATC radar beacon ground stations. The defruiting equipment is being built by Radio Receptor, and the remaining equipment by Brubaker Electronics. Airborne transponders are built by Wilcox Electric and Collins Radio. Delivery of the new ground station equipment is scheduled to begin late this year.

Westinghouse Studies Infrared Systems

By Philip J. Klass

Baltimore—Airborne infrared search and track system, employing new signal enhancement techniques which are expected to double presently obtainable ranges of detecting airborne targets, is scheduled to be evaluated soon by Bureau of Aeronautics in a Navy Douglas F4D.

Developed here by Westinghouse Air Arm Division for airborne intercept (AI) fire control system use, the new infrared system might also prove useful as a self-contained airborne proximity warning device for air collision avoidance.

A number of infrared system developments are under way here to complement Air Arm Division's capability in airborne radar for use in surveillance, fire control and missile guidance. Many of these projects are based on promising new infrared component developments emerging from the company's research laboratory. These include:

- **Infrared imaging tube**, called Thermicon, which resembles a conventional television videcon tube except that it is sensitive out to longer infrared wavelengths. The Thermicon also boasts of high sensitivity, resolution, fast response and a wide field of view.
- **Ultra-sensitive infrared detector**, using gold-doped P-type germanium crystal, which Westinghouse data indicates will develop a much larger signal than conventional detectors and over a wider portion of the infrared spectrum.
- **"Two-color" infrared detector**, which can simultaneously detect both hot and cold targets.

Airborne Intercept System

Air Arm's new infrared airborne intercept system is designed to display its target sightings on a conventional radar type C-scope cockpit presentation. This enables a single display to handle both infrared and radar data. In the automatic search mode the system sounds an alarm whenever a new target is detected.

The present prototype system has a four-degree field of view. It can be operated in either of two automatic search modes, one with a scan area of 80 deg. in azimuth by 16 deg. in elevation, the other a 30 x 16 deg. area. When the target is detected, the pilot uses a small control stick to position a cursor over the target blip on the scope, then initiates lock-on, after which the infrared head will track the target continuously. During track mode, the tracking head provides both target position and rate signals.

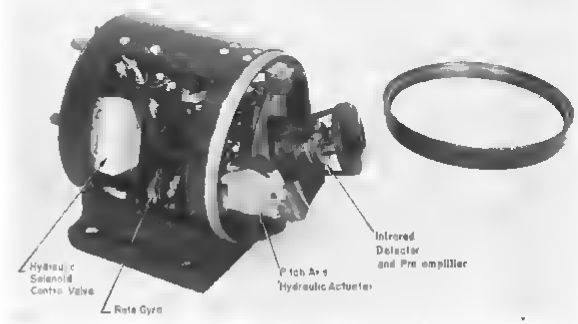
The prototype system, including six-inch tracking head, cooling provisions, amplifiers and control weigh a total of only 50 lb., excluding the scope display. In the production version, the amplifier could be constructed more compactly to lower this figure, according to Harley Lindemann. Lindemann is manager of detection systems in Air Arm's advanced development engineering group. Total power consumption for the infrared system is only 125 watts.

By way of comparison, an airborne radar with roughly equivalent performance would weigh about 250-300 lb. and consume 1,500 watts electric power, Lindemann estimates, pointing up one of the important advantages of infrared systems.

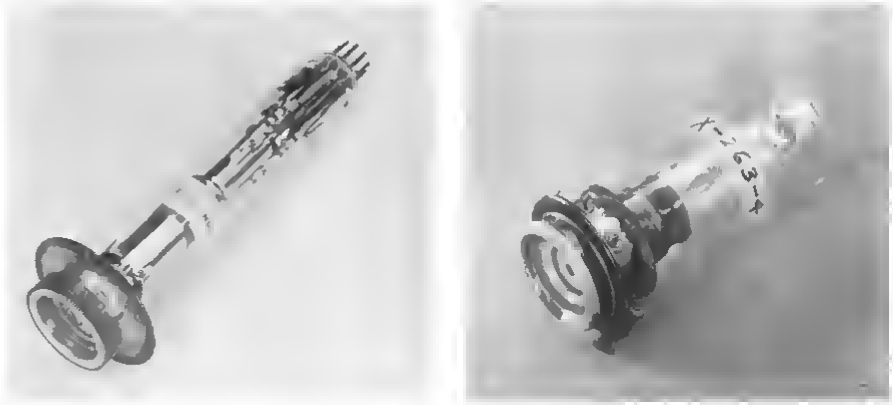
Westinghouse has packed a number of design features into a six-inch diameter scanning head which weighs only 10 lb., including two rate gyros for azimuth and elevation stabilization. These include:

- **Hydraulic actuators**. To reduce weight and bulk of the scanning head, and to provide rapid scan rates, Westinghouse designed tiny hydraulic rotary actuators to directly drive the scanner in azimuth and elevation. Each of the two actuators measures only 1¾ in. diameter by ⅝ in. thick, weighs only 4 oz., and develops 41 in.-lb. at hydraulic pressure of 1,000 psi. Hydraulic power is obtained from regular aircraft supply. If electric motors had been used, each

INFRARED AIRBORNE INTERCEPT system developed by Westinghouse can search out and track airborne targets at greater ranges than current systems. Major elements, from left to right, are tracking head, C-scope display and control box.



INFRARED TRACKING HEAD, gyro-stabilized, measures 6 in. in diameter, has a 4.3 in. collector and weighs only 10 lb. Miniature hydraulic actuators and control valves provide high scan and tracking rates, yet permit very compact construction.



INFRARED COMPONENT developed by Westinghouse include Thermicon infrared imaging tube (left) which exhibits high sensitivity, fast response out through long wavelengths, and a "two-color" gold-doped germanium detector which can distinguish between two objects at only slightly different temperatures. Detector has a 0.1 microsecond response time between one and 10 micron wavelengths.

axis would have required a motor measuring 1¾ in. diameter by 3¾ in. long, weighing 1½ lb., Lindemann said.

• **Built-in test:** Scanning head contains a small infrared source and mirror system which enables the pilot to check out both the sensitivity and lock-on operation of the system before a mission.

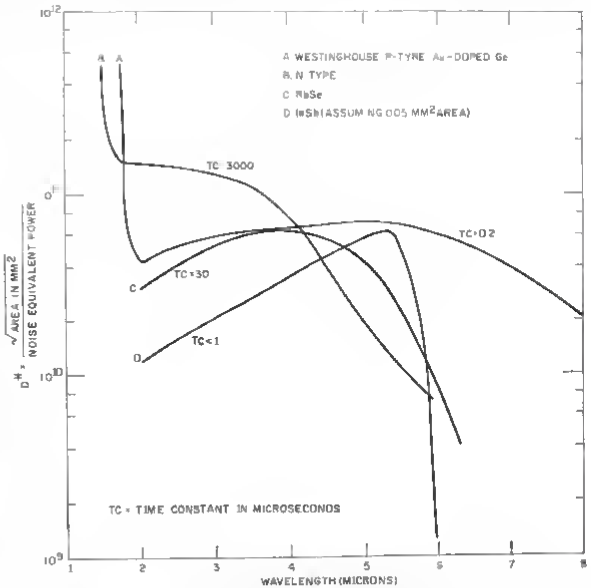
• **Preamplifier:** The all-transistor preamplifier is built around the circumference of the infrared detector to minimize signal attenuation and the introduction of spurious noise signals.

• **Cooling:** Super regenerative cryostat is included to cool the infrared detector for improved sensitivity. Cooling gas (nitrogen) is introduced into the detector by means of a rotary joint which eliminates the need for flexible tubing.

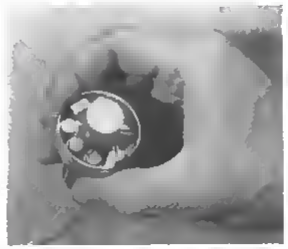
Through use of direct hydraulic drives, Air Arm has been able to squeeze a 4.3 in. collector (corresponding to antenna size in a radar) into a six-inch diameter scanning head to achieve an effective aperture of 8½ sq. in. Folded reflective type optics with a 3.6 in. focal length are used in the prototype system. Wideband optics are used to permit change in the type of detector used, for different target applications.

For competitive and security reasons, Westinghouse is tightlipped about certain design details. Using what it terms "cancellation techniques," a company spokesman says the new infrared system "practically eliminates background radiation problems," which can cause conventional infrared systems to mistake small puffy clouds for airborne targets. Lindemann says the new Air Arm system also can track targets very close to the position of the sun without losing them.

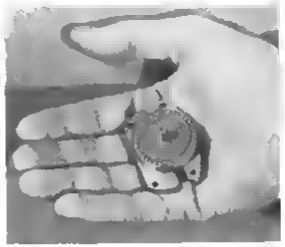
Infrared imaging tubes developed and used during World War II operated in the very short wavelength region of the infrared spectrum, making them useful only against extremely hot targets or when the target is illuminated by an infrared spotlight. For aerial reconnaissance against comparatively cool targets, infrared system designers previously have been forced to use a mosaic of detectors, with an electromechanical commutator to scan from one element to another. The difficulty of producing mosaics with a high degree of element uniformity plus noise introduced by



SENSITIVITY of new gold-doped P type germanium infrared detector is shown as a function of wavelength alongside response of three other types of infrared detectors.



PREAMPLIFIER for airborne intercept system is built around the periphery of the infrared detector to reduce noise pickup.



TINY hydraulic actuator is used to drive the infrared tracking head.

commutation of low-level detector signals has limited system sensitivity and performance.

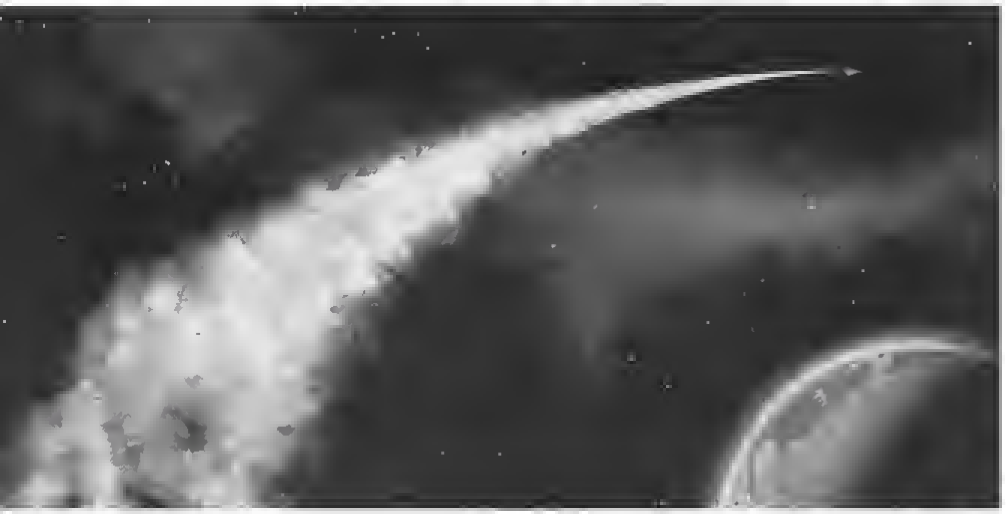
The new Westinghouse Thermicon opens the way to the design of greatly improved aerial reconnaissance systems because of the device's high sensitivity, resolution and fast response time, the company says. For example, video integration techniques can be used to reduce background radiation and improve target resolution. Track-while-scan techniques used in radar systems also can be employed to permit simultaneous tracking of multiple targets.

Present prototype models of the Thermicon measure one inch in diameter by nine inches long. The tube is just emerging from the research laboratories, but should be in pilot production before the end of the year, a company spokesman says. Detailed performance data is classified at present.

A recently developed gold-doped P-type germanium infrared detector, currently in production at Westinghouse Semiconductor Department, exhibits high sensitivity over a wide portion of the infrared spectrum, from approximately one to 10 microns when cooled to liquid nitrogen temperature of about 78K. This, coupled with the device's extremely fast response time, makes it greatly attractive for airborne reconnaissance systems working against relatively cool ground targets.

The new gold-doped germanium de-

DYNA-SOAR



Dyna-Soar (for dynamic soaring) is a joint project between the Air Force and the NASA, and is an attempt to solve the technical problems of manned flight in the sub-orbital regions. Advance knowledge on the project indicates how a boost-glide vehicle can operate from the outer fringes of the atmosphere where it can maneuver and be recovered undamaged. Studies show that by varying the original rocket boost, and thus the velocity, and with the control available to the pilot, the Dyna-Soar aircraft can circumnavigate the earth, followed by a normal and controlled landing. Boeing Airplane Company, one of the competing companies for the development contract for the complete boost-glide system, has delegated to RCA the responsibility for the development of important electronic components of Dyna-Soar.

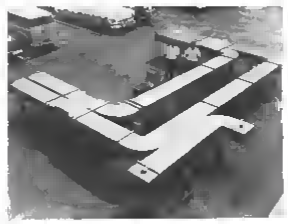
tector has a noise-equivalent-power (NEP) of 5×10^{-11} watts at temperature of 78K, and an NEP of 1.6×10^{-13} watts at 60K with a time constant of better than 0.2 microsecond, Westinghouse says. By way of comparison, a conventional lead selenide detector operating at 78K has comparable sensitivity only from approximately two or five microns, after which it falls off sharply and its time constant is about 30 microseconds.

Signal level output from the gold doped germanium detector as well as the cell noise level are a direct function of the direct current bias current applied so that the signal-to-noise ratio of the cell is essentially constant at all normal bias levels. This enables the infrared system designer to select a detector bias current which makes the rms noise contributed by the preamplifier insignificant.

Under sponsorship of Wright Air Development Center, Westinghouse has developed a "two-color" gold-doped germanium infrared detector which can effectively discriminate between targets of slightly different temperatures. Operating range is one to 10 microns. With a signal-to-noise ratio of +1, the cell can discriminate between two targets whose temperatures differ by only 0.02K when the two are at approximately 283K (10C), Lindemann says. Security prevents disclosure of operating principles, the company says.

Air Arm has also developed a new closed-cycle cooling system for infrared detectors which is intended to eliminate the need for replenishing cooling fluid after each mission.

It consists of a diaphragm type compressor driven by a small hydraulic actuator powered from vehicle's main hydraulic supply. The system achieves temperatures of approximately 98K and weighs about 10 lb.



Waveguide Complex

Giant waveguide complex, built for an undisclosed extremely long range, high power early warning radar (probably the Ballistic Missile Early Warning System) by Airtron, dwarfs two company engineers. Designed for operation at UHF frequencies, the resonant rings of the waveguide multiply input power by factor of more than 20:1.

Higher-Temperature Capacitors:

New Dielectric Materials Help Break the Heat Barrier

By Marc F. Wermuth, Staff Engineer, Airborne Accessories Corporation

Special Mylar*, Teflon† and mica constructions permit continuous operation up to 600°F

Three new types of special high-temperature motor-starting capacitors, utilizing Mylar, Teflon and mica dielectric respectively, have been developed recently by Airborne. The Mylar and Teflon types are wound of very thin metallized film for greatest possible miniaturization. The mica type is wound of a sandwich of aluminum foil and thin, pure mica ribbon, metallized mica not being procurable. All are encapsulated with thermoplastic polyamide or thermosetting epoxy resins (depending on temperature range) in sealed, cold-drawn steel cans with fused glass terminals. This construction provides low inductance units of exceptional mechanical sturdiness and environmental resistance.

As an alternate construction for less demanding applications, encapsulation in epoxy sleeves, with leads brought out through potted ends, is also available.

Mica for highest temperatures

The great advantage of mica as a dielectric is its ability to maintain its physical and electrical characteristics at temperatures up to 1000°F. All dielectric materials undergo severe reductions in insulation resistance at high temperatures, but with mica the critical value is reached around 600°F. Full voltage ratings up to this point are thus permitted. And with the right epoxy resin impregnant, mica capacitors are well able to withstand overtemperatures without damage . . . if not simultaneously subjected to full rated voltages.

Mica capacitors are three to four times larger than Mylar or Teflon units of comparable capacitance and voltage rating. This is because a greater thickness of dielectric must be used in addition to a separate layer of aluminum foil.

Mylar and Teflon for intermediate high temperatures and small size

Mylar can be worked continuously up to 300°F and Teflon up to 400°F. For applications below these limits, but above the normal 185°F limit of more conventional insulating materials, metallized Mylar and Teflon offer high dielectric strength. They make possible wound capacitors of very small size with good voltage ratings and excellent capacitance-to-volume ratios.

A further advantage of metallized Mylar and Teflon capacitors is their self-healing characteristic. The short occurring when the dielectric is ruptured instantly burns the thin metallic coating back from the edges of the rupture, making further flashover impossible. Yet the amount of metallic coating burned away is so minute that hundreds of such self-healings have little effect on capacitance. Resistance to overvoltages can thus be considered excellent. Resistance to over*temperatures*, on the other hand, is not an outstanding characteristic of Mylar or Teflon—a design factor to keep in mind.

Summary

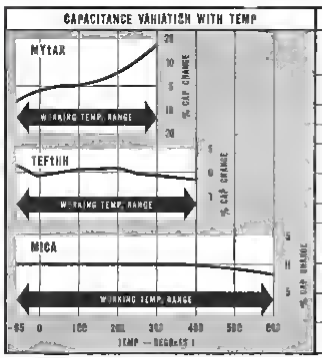
MYLAR: For intermediate high temperatures, high voltage and smallest size. Continuous operation at 300°F with ratings up to 1000 WVDC. Capacitance variation with temperature good, but not as good as that of Teflon or mica types.

TEFLON: For intermediate high temperatures and small size. 600 WVDC up to 400°F without derating.

MICA: For highest temperatures. Continuous operation, 600 WVDC without derating up to 600°F. Higher temperatures possible with derating. Larger in size than equivalent Mylar or Teflon capacitors.

For proposals on your specific capacitor requirements, write AIRBORNE ACCESSORIES CORPORATION, HILLSIDE 5, N.J.

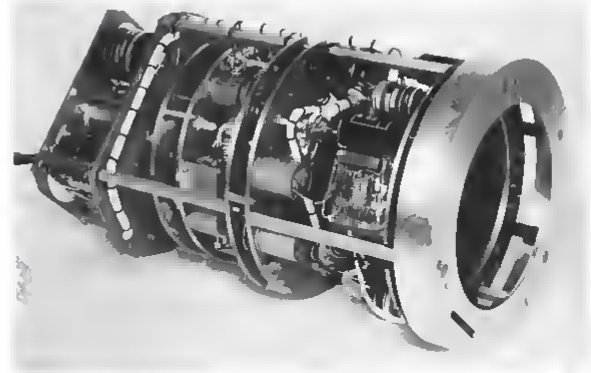
*DuPont's tm for its polyester film
†DuPont's tm for its tetrafluoroethylene resin



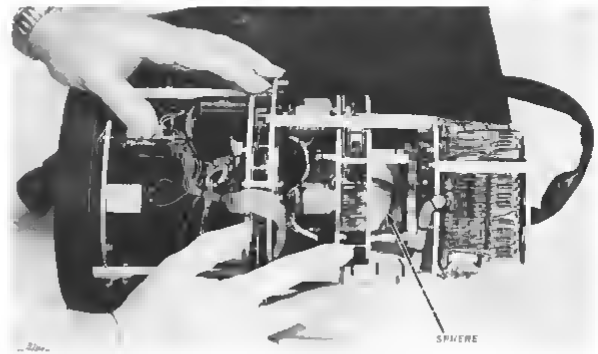
CAPACITANCE VARIATION WITH TEMP

TABULATED CHARACTERISTICS—AIRBORNE SPECIAL HIGH TEMPERATURE CAPACITORS

TYPE	MYLAR Wound, Metallized Mylar Film	TEFLON Wound, Metallized Teflon Film	MICA Wound, Alum. Foil with Mica Ribbon
Working temp. range	-65 to + 300°F (-65 to + 150°C)	-65 to + 400°F (-55 to + 205°C)	-65 to + 600°F (-55 to + 315°C)
Voltage ratings	200–1000 WVDC	200–600 WVDC	200–600 WVDC
Capacitance range	.01 mfd up	.01 mfd up	.01 mfd up
Capacitance variation with temp.	Very good to 150°F Good 150–300°F	Excellent to 250°F Very good 250–400°F	Excellent to 350°F Very good 350–600°F
Insulation resistance	50,000 meg x mfd at 78°F 10 meg x mfd at 257°F	500,000 meg x mfd at 78°F 75 meg x mfd at 300°F	10,000 meg x mfd at 78°F 4 meg x mfd at 600°F
Dielectric strength	4000 v/mil	1500 v/mil	1000 v/mil
Size	D L	11XD 11XL	3in4XD 3in4XL
Capacitance change vs time at max. working temp.	-5% or less after 250 hr	-5% or less after 250 hr	-5% or less after 250 hr
Overvoltage resistance	Excellent (Self healing)	Excellent (Self healing)	Non-self healing
Short-time exposure to overtemperature	Poor	Poor	Very good with derating



NAVY three-dimensional flight indicator in seven inch-diameter case will undergo flight evaluation soon. The 10 lb indicator is designed to give a pilot the feel of flying contact by showing rotating clouds during a turn, simulated horizon that pitches and rolls, and horizontal lines that move toward pilot at speed proportional to airplane velocity. Translucent sphere (arrow below) with many degrees of freedom, is heart of the device



Three-Dimensional Pilot Display Will be Flight-Tested in F9F-8T

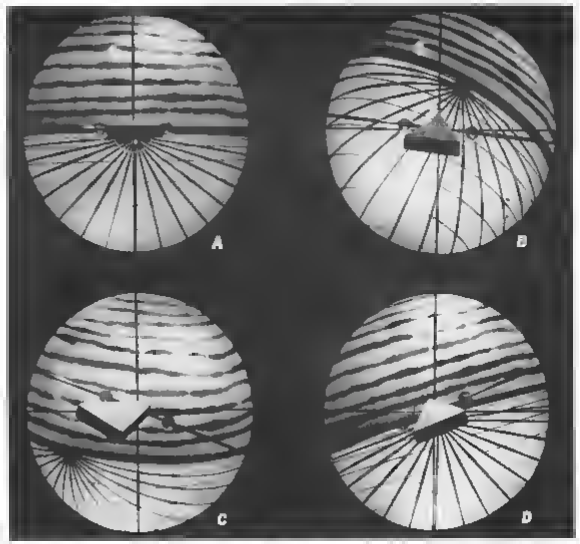
Johnsville, Pa—First flight in Navy's evaluation of a cockpit indicator which combines attitude, heading, rate-of-turn, flight director and altitude commands and an indication of forward velocity in a single display with a three-dimensional feel, is scheduled soon in two Grumman F9F-8T aircraft being instrumented for the evaluation.

The instrument, called a "Contact Analog Flight Display," is an attempt to speed the use of some of the advanced ideas of the longer-range Army-Navy Instrument Program (ANIP). DV-10 panel which will employ cathode ray tubes for TV-type presentation of flight data (AW Aug. 11, p. 48).

The CC-4 attitude indicator was conceived here by Naval Air Development Center's Aeronautical Instruments Laboratory. The device was designed and constructed by Waldorf Instrument Co., Huntington Station, N. Y. The indicator already has undergone initial evaluation in an NADC flight simulator.

Each of the two-place F9F-8T aircraft will be fitted with a conventional cockpit panel and one of the new Navy DV-4 simplified panels, including the new three-dimensional indicator and a horizontal situation display. Both are electromechanical devices in contrast to the all-electronic displays under development for the advanced DV-10 program.

During the flight evaluation, expected to last six to nine months, Navy plans



INDICATOR presentation for different flight situations is shown. In (A), the airplane is in straight and level flight and on desired flight path. In (B), the airplane is nose down in a slight left bank and in a slow rate of turn, slightly high and to the right of the desired flight path. In (C) the aircraft is climbing, has a rapid rate of turn to the right, and is considerably above and to the right of the flight path. In (D), the airplane is banked to the right and is above the desired flight path.

to use 20 to 25 different pilots—some experienced, some students. Aircraft are being heavily instrumented to record 24 different functions, including stick motions, which will permit direct comparison of the relative effectiveness of conventional and the new instrumentation, according to Louis Gnarino, chief of the Design and Stabilization Division of NADC's Aeronautical Instruments Laboratory.

The Waldorf contact analog flight display is housed in a seven-inch diameter case, 11 in. long, weighing 10 lb., including the all-transistor servo amplifiers required for the instrument's servo systems.

Heart of the indicator is a translucent sphere whose upper half is painted to resemble cloud formations. Inside this sphere is another translucent sphere whose lower half has black lines which converge to the sphere's horizon, giving the appearance of a number of parallel railroad tracks.

Operating from signals obtained from a separate vertical gyro, the two spheres are driven clockwise or counterclockwise by tiny servo motors with respect to a set of large crosshairs whenever the airplane rolls. The two spheres rotate up or down whenever the airplane changes pitch attitude.

When the airplane changes heading, the upper half of the outer sphere (with clouds) rotates in an appropriate direction and continues to rotate so long as the airplane is in the turn.

The lower half of the inner sphere (with converging lines) rotates only through a limited angle, proportional to the airplane's rate of turn. Thus it moves only at the initiation and termination of a turn, taking up a position proportional to the rate of turn after the airplane has entered the turn.

The signal for the servo motor driving the upper half of the outer sphere is obtained from a separate directional gyro. The first derivative of this signal provides the rate-of-turn signal for operating the motor that rotates the inner sphere.

The lower half of the outer sphere, which can be rotated independently of the top (clouds) half, gives the pilot an indication of his airplane's forward speed.

Horizontal-spiral hoops inscribed on the lower half of the outer sphere give the impression of horizontal lines moving toward the pilot, like flying over railroad ties, when the lower half is rotated.

A signal proportional to the airplane's indicated air speed or ground speed is

Progress in Space Technology

How General Electric delivered first U.S. operational re-entry vehicle

General Electric Missile and Space Vehicle Department helped USAF Ballistic Missile Division solve re-entry problem . . . speed Thor operational readiness.

CAPABILITIES DEVELOPED RAPIDLY—Early in 1955, General Electric's Missile and Space Vehicle Department began research and development work on the vitally important re-entry phase of the USAF ballistic missile program. A skilled core of G E scientists with hypersonic and missile technology experience were pulled together from all parts of the Company. Special research tools were developed and put into use at MSVD's new Aerosciences Laboratory. Advanced shock tunnels reproduced high Mach air flows—10,000 to 25,000° F plasma jets simulated extreme re-entry heats. With such new tools, G E gained vital knowledge of the re-entry environment.

FLIGHT TEST PROVED DESIGN—MSVD engineers were convinced that the heat-sink type re-entry vehicle offered the best approach to providing the Air Force with an *operational* weapon at the *earliest possible date*. Later, flight tests proved the soundness of the General Electric approach. On schedule, only 30 months after research and development began, the Air Force launched the free world's first operational re-entry vehicle on Thor.

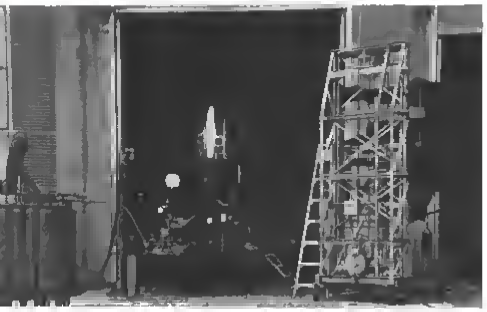
Missile and Space Vehicle Department engineers were also able to make important advances on other fronts associated with the re-entry challenge. Complex re-entry vehicle ground support equipment was developed; rocket-sled tests aided in solving fuzing problems. It was also necessary to build one of the country's most advanced data processing and computation centers to keep pace with the need for rapid processing of Air Force re-entry data.

PRODUCTION ON SCHEDULE—To prepare for Thor missile re-entry vehicle production, General Electric acquired and developed special manufacturing facilities and techniques. Proof of the smooth, rapid transition from research and development to production is the fact that Thor re-entry vehicles have passed *all operational qualification tests* and are being delivered on schedule to the Air Force for air lift to key overseas bases.

ADVANCED NOSE CONE DEVELOPMENT—Meanwhile, development continues on more advanced re-entry vehicles. Last year, one such G E re-entry vehicle, the Thor-Able, successfully re-entered at an ICBM range of over 5500 nautical miles. With more than four years of success as an associate contractor on the Atlas, Thor and other programs, *General Electric is the leader in re-entry vehicle development and production experience.* This proven competence will continue to grow as MSVD applies its re-entry experience to the expanding list of new missile and space projects. *Missile and Space Vehicle Department of the Defense Electronics Division.* 224-50

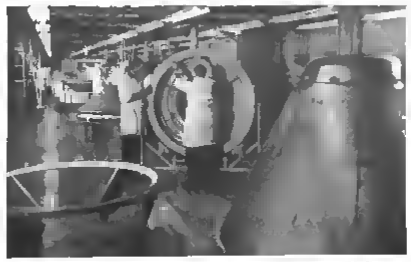
A GENERAL ELECTRIC RE-ENTRY VEHICLE is mated to a Thor Missile in the first SAC operational test flight exercise from Vandenberg Air Force Base

Official U.S. Air Force photograph



NATION'S LARGEST PLASMA JET PLAYS KEY ROLE in providing information leading to the solution of the re-entry problem. Plasma Air Arc and many other re-entry research tools were developed by MSVD Aerosciences Laboratory scientists.

OVER 1½ YEARS OF FLIGHT TEST EXPERIENCE on Atlas, Thor and Thor-Able missiles has been gained by General Electric covering both heat-sink and ablating types of re-entry vehicles for the USAF. These three ballistic missiles are pictured above.



RE-ENTRY VEHICLES ARE ASSEMBLED at MSVD facilities in Burlington, Vt., for both THOR and ATLAS ballistic missiles

These Free Booklets Describe MSVD Ballistic Missile Re-entry Vehicle Work.

Indicate the brochures that you would like to have and send to: Section E224-50, General Electric Co., Schenectady, New York.

Capabilities of G E's Missile and Space Vehicle Department	GEA-6904A
Space Technology Progress	GEA-6876
Heat Sink Nose Cone	PIB-2
Design and Fabrication of Re-entry Vehicles	GER-1583
Heat Protection of Re-entry Vehicles	GER-1582

Progress Is Our Most Important Product

GENERAL ELECTRIC

obtained from external sensors like an IAS indicator, Doppler radar or navigation computer, and applied to the servo motor which rotates the lower half of the outer sphere at a proportional velocity.

To display fly up, down, left, right commands from a flight director or fire control system, the Waldorf indicator uses a tiny pivoted wedge-shaped element mounted directly in front of the concentric spheres to provide the illusion of a flight path stretching out from the airplane into space. This flight path indicator can be tipped 30 deg. up, down, left or right and also can be rotated, corresponding to a roll command, through 360 deg.

Altitude command is displayed by a small flag located at the nine o'clock position along the rim of the indicator. The flag is operated by direct current galvanometer movement.

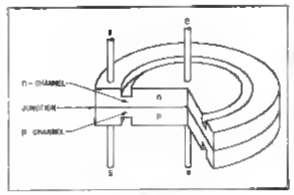
Integral lighting is used throughout the instrument. Lamps mounted inside the innermost sphere provide necessary illumination of markings on the spheres. The pilot can select either white or red lighting.

A Fresnel lens system collimates the image of the sphere and flight path indicator to prevent parallax and to give the pilot the illusion that the indication is located at infinity. The present lens system limits the angle from which the pilot can view the instrument to nearly a head on position.

Field Effect Tetrode Combines Functions

New York—Novel semiconductor device, called the field effect tetrode, which can perform a number of electronic functions that previously required elaborate circuitry or else couldn't be performed at all, has been developed by Bell Telephone Laboratories.

New device can be made to function as a transformer, gyrator, isolator, nondistorting modulator or a short-circuit stable negative resistance. It is another example of what is becoming known as "intrinsic solid circuitry" or "molecular electronics" (AW April 27, p. 54).



FIELD effect tetrode's construction.

The field effect tetrode consists of a disk of semiconductor material with a diffused junction in which a circular trench is cut into each face. Depth of the trench extends to within about one mil of the junction. Two leads are attached to each face, one inside the trench, the other outside.

When a voltage is applied across the junction, the thickness of the depletion layer adjacent to it is increased or decreased, depending upon bias voltage polarity. This in turn increases or decreases the resistance of each channel between the bottom of the trench and the junction.

The device has no direct analog either in tubes or conventional transistors, Bell says. It functions either as a transformer without dc isolation or as a gyrator, depending upon the bias voltage polarity. One interesting possible application of the gyrator function is impedance inversion, which suggests the device could be used to make a semiconductor capacitor appear to be a high Q inductor—a circuit function not previously obtainable with semiconductors. When properly biased, the device functions as an isolator, allowing passage of alternating current only in one direction.

Another promising application of the new field effect tetrode is as a distor-

tionless modulator or electronically controlled resistor for large signals. A relatively low-frequency control voltage can be used to vary the width of the depletion layer and thus the resistance of the device. If a high ratio of signal to control frequency is employed, simple capacitors functioning as a high-pass filter can be used to isolate one from the other so signal voltage does not appear across the junction, BTL says. This means the output signal can be very much higher than control voltage without being distorted by self modulation.

When only the inner lead of one face and the outer lead from from the other are used, the device functions as a two-terminal a.c. short-circuit stable negative resistance. In experimental model, using boron doped silicon crystal with phosphorous diffused junction, Bell has achieved this circuit function over a range of 30-250 v. at 0.6 to 0.7 ma.

Expansions, Changes In Avionics Industry

Bio-Physical Research Instruments, Inc., is new company formed to develop electronic instruments to measure human state of consciousness in manned space vehicles and aircraft. New company, a subsidiary of Ruska Instrument Corp., is headed by Walter Ruska, president, and C. D. Varner, executive vice president. Company's address: 6121 Hillcroft, Sharpstown Industrial Park, Houston, Tex.

Other recently announced expansions, mergers and changes in the avionics field include the following:

• **Electronic Specialty Co.**, Los Angeles, has purchased **Electrical Engineering & Manufacturing Corp.**, Los Angeles, producer of a.c. and d.c. motors. Combined company will have annual sales of about $7 million. Frank Gindroz continues as general manager of Emico which will operate as division of Electronic Specialty Co.

• **Varian Associates**, Palo Alto, Calif., has acquired an 80% interest in **Bomac Laboratories, Inc.**, Beverly, Mass., both producers of microwave components. Bomac will continue to operate as a separate unit, headed by its original founders, who join Varian board of directors.

• **Northrop's Nortronics Division** will build a $4 million engineering, research and pilot production facility. Occupancy is slated for mid 1960.

• **Grumman Aircraft** will start construction shortly on its $4 million avionics systems center, a 55,000 sq. ft. structure, to be used in development, evaluation and testing of avionics systems for aircraft and missiles. Completion is slated for late this year.

• **Piasecki Aircraft Corp.** has opened

new 65,000 sq ft Mayfield Electronics Division near Scranton, Pa., for producing and testing avionic gear.

• **The Merriam Instrument Co.** has purchased **I-L-S Instrument Corp.**, Cleveland, manufacturer of electronic instrumentation. New acquisition will be operated as a division with no contemplated change in personnel or location.

• **Pacific Industries, Inc.**, San Francisco, has purchased business and assets of **Computer-Measurements Corp.**, North Hollywood, Calif. No change of location or personnel is planned for newly acquired division.

• **Rheem Manufacturing Co.** and group headed by Dr. E. M. Baldwin will form new company to develop and produce semiconductor devices, according to present plans. Baldwin, former general manager of Fairchild Semiconductor Corp., will be vice president and general manager of the new Rheem subsidiary to be located in San Francisco area.

• **The Dalto Corp.** is name of newly formed company that will manufacture Dalto Visual Flight Simulator Attachment which gives visual pattern of approach and runway lights for use with flight simulators. Waid D. Davis is president of new company, Herbert Chermin is vice president. Address: Hotel Continental, New York International Airport.

• **Hoffman Electronics** has established its new Hoffman Science Center in Santa Barbara, Calif., pending construction of permanent facility. New division will be devoted to research in electronics field.

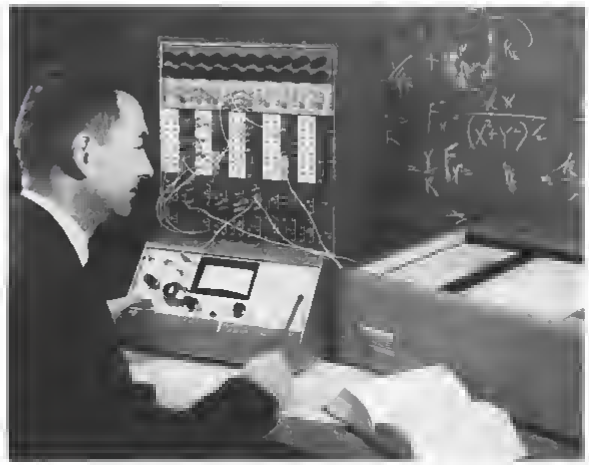
• **Ling Electronics** and **Altec**, both of Los Angeles, will merge to form Ling-Altec, with J. J. Ling as board chairman.

• **Westinghouse Electric** has set up an Anti-Submarine Warfare Project at its Air Arm Division in Baltimore, to be headed by Joseph L. Dickey.

FILTER CENTER

▶ **Satellite Weather Radar**—Meteorological satellite equipped with radar to measure severity and location of precipitation around the globe is one long-range objective of the National Aeronautics and Space Administration. Strength of radar echo return will give indication of precipitation severity. Miniaturized version of present radar altimeters might be used for such purpose.

▶ **Arinc Air Data Computer Specification**—Airlines Electronic Engineering Committee (AEEC) will soon form a group to draw up a characteristic (specification) for an airline type central air



Desk-Top Analog Computer Designed

Desk-top analog computer is completely transistorized but versatile enough to perform 95% of the routine mathematical operations of conventional electronic design calculations, according to Electronic Associates, Inc., Long Branch, N. J. Accuracy of the 20 amplifier TR-10 computer is 0.1%. Size is 15 in. wide, 17 in. deep, and 24 in. high; weight is about 80 lb. Readout is by meter or by an accessory X-Y plotter or digital printer. Price of the basic computer is quoted as under $4,000.

data computer. Interested air data computer manufacturers may contact William Carnes, Aeronautical Radio, Inc., 1700 "K" St., N.W., Washington D.C., for further information.

▶**Major Thermoelectric Program**—Westinghouse Electric will design and construct a thermoelectric generator capable of producing 5,000 w. of electric power for Navy Bureau of Ships under a recently awarded contract. The device, believed to be the largest thermoelectric generator yet attempted in the U.S., will convert heat directly into electricity without moving parts.

▶**Aerojet Spots Near-Misses**—New system for measuring relative trajectory, velocity and distance by which a missile misses a target drone has been developed by Aerojet-General under Navy Bureau of Aeronautics sponsorship. The system, called Firetrac, is a phase-comparison system operating in the VHF telemetry band. Airborne elements, weighing 20 lb., are installed in drone. System is being used in both Navy and Air Force drone programs, Aerojet-General says.

▶**High-speed Semiconductor Switch**—A silicon P-N-P-N controlled switch, which functions similarly to controlled rectifier but at higher switching rates, has been announced by Solid State Products, Inc. Unlike a conventional transistor, the device requires only brief pulse to turn it on. New device provides current gains of 500 and power gains of 250,000 at output peak current levels as high as 1,000 ma., company says. For technical details write company at One Pingree St., Salem, Mass.

▶**Authors Wanted**—Fifth National Communications Symposium, Oct. 5-7, to be held in Utica, N.Y., is seeking technical papers. There will be two days of unclassified sessions followed by one day of "Confidential" papers. Prospective authors should submit 150-word abstracts by June 30, along with a brief biographical sketch, to Mr. Ralph L. Marks, Technical Program Chairman, Griffis Air Force Base, New York.

▶**Russian Atomic Clock**—Soviet scientists have developed an ammonia Maser frequency standard with stability equivalent to a clock that loses only one second in 300 years, according to recent Russian article. Device will be used for extra-long-range radar, improved radio transmission and for physical measurements, Soviets report. Digest of article appears in recent issue of "Information on Soviet Block International Geophysical Cooperation—1959," a weekly review of scientific activities under IGY-extended. Publication is available from Office of Technical Services, Dept. of

Commerce, Washington 25, D. C. Subscription for all 1959 issues is priced at $12.00.

▶ **Florida Electronics Directory**—List of Florida companies engaged in development and or manufacture of aircraft, missiles, electronics and scientific instruments and their products is contained in a directory compiled by Florida Development Commission, Industrial Service Division. For copies, write to Industrial Services Division, Tallahassee, Fla.

▶ **Power Behind Voice to Venus**—Giant klystron tube, produced by Eitel McCullough, Inc., powered the Massachusetts Institute of Technology's radar which recently established contact with planet Venus, company reports. The super power klystron, developed under Rome Air Development Center sponsorship, currently is in production. Eimac klystrons also will be used for NATO's new tropospheric scatter communications network, the company says.

▶ **Signed on Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

- **Kollsman Instrument Corp.**, $12 million from Air Materiel Command, for additional production of Astro Compasses.
- **I-T-E Circuit Breaker Co.**, Philadelphia, two contracts from Bendix Radio totaling more than $1 million for radar antenna systems. Antennas are prototypes of new early warning radar for use on DEW Line. Reflector will measure 60 ft. wide, 25 ft. high.
- **Consolidated Systems Corp.**, wholly owned subsidiary of Consolidated Electrodynamics Corp., a $348,700 contract from National Aeronautics and Space Administration, for automatic data recording and monitoring equipment for rocket engine testing at Edwards AFB.
- **Bendix Radio** reports a purchase order for more than $700,000 from Royal Canadian Air Force for airborne VOR/ILS receivers. Equipment includes new lightweight RA-21A/NVA-21A navigation systems and GSA-8 glide slope receiver, with associated indicators.
- **Electronic Communications, Inc.**, St. Petersburg, Fla., $2 million increase in contract authorization from Hughes Aircraft for communications and data link systems.
- **Bogue Electric of Canada, Ltd.**, Ottawa, $300,000 for power supplies from Burroughs Corp. for use in latter's AN/FST-2 SAGE data processing equipment.
- **Marquardt Aircraft Co.**, Pomona Division, $2 million USAF contract for AN/GPS-T4 radar signal simulators for training Air Force intercept controllers.

Cessna Acts to Capture Export Market

By Erwin J. Bulban

Wichita—Recent "task force" approach by a Cessna Aircraft Co. management and technical team in setting up an international export conference in Nice, France, to explore European, African and Near East business aircraft market potentials is expected to pay dividends in boosting immediate sales and the rate of sales growth above the current curve.

Team members expressed considerable optimism about the prospects for increased sales and general improvement in business flying activity in the next few years in the areas it covered. They cited their belief that Cessna's exports in the next year could double compared with last year in the areas they visited.

EUROPEAN markets are emphasized to dealers by export manager M. F. Mellinger.

DETAILED SALES KITS, covering techniques new to many dealers, were studied at Nice.

Important Impressions

Two important impressions, which will strongly influence Cessna's future consideration of the European business airplane market, were emphasized by two of the top members of the team interviewed by Aviation Week here:

- **Interest in business flying in the European area is at approximately the same point on the curve that it existed in the United States some five years ago,** according to Cessna Marketing Manager Frank Martin. Actual activity is far below the corresponding curve in the United States at that time, but to consider this aspect solely would be to miss an important point: receptivity by the potential customer is there, spurred by experiences provided by visiting U.S. businessmen, by the foreign businessman's exposure to business flying activity during visits to this country and by the increasing effect of publicity regarding executive flying as practiced in this country.
- **Fairly stiff design competition from foreign manufacturers in the general aviation category approximately three to five years from now is being assumed by top-level Cessna personnel as a result** of a study of facilities abroad during the team's visit. Del Roskam, vice president-manager of the commercial aircraft division said: Currently, European general aviation aircraft are considerably backward compared with contemporary U.S. designs, he noted. This disparity is primarily due to overseas designers emphasizing one particular performance feature over all others, which has resulted in their airplanes having very limited utility. United States light aircraft designers have learned to combine speed, range, effective payload, comfort, and small-field operating characteristics, making some compromises to provide maximum utility, Roskam noted.

Considering that European aircraft designers do not lack technical know-how and that their plants are getting more and more modern production equipment, Cessna says that it must consider that they will take heed of the growing market and build airplanes more compatible to business aviation. In fact, some foreign firms have already indicated strong interest in building U.S. designs under license.

For the next few years at least, Cessna feels that U.S. manufacturers must establish themselves firmly in this area by building strong distributor-dealer organizations to the levels of those in this country. When the European manufacturers become a strong competitive factor, the groundwork will then be ready for U.S. builders to establish production plants abroad, if necessary. Cessna already is studying the problems entailed in developing such facilities as part of its long-range planning.

The Cessna team that went to the company organized international export management conference in Nice included commercial export manager M. F. Mellinger, Del Roskam, commercial aircraft chief engineer Jerry Gerteis, Frank Martin, export regional sales manager Dallas W. Cederberg, and regional service manager Paul Bollman.

The three day meeting was attended by about 30 Cessna dealers and prospective dealers and covered marketing and sales concepts, design philosophy, current product line, advertising, sales promotion, publicity, service and financial procedures. The company's com-

plete 1959 line of business airplanes was taken along and used for demonstration purposes.

For many dealers this was their first exposure to the latest techniques developed by the company and their first opportunity to discuss problems with company people and mutual problems with one another. This opportunity provided a cross-exchange of information that will speed development of the dealer organization by many years, Martin said. This close contact, plus expressed interest of many dealers to establish closer liaison with the factory will result in the foreign sales outlets jumping the long learning curve experienced here and starting out with mature techniques, he noted.

As an indication of how interest in business flying is taking hold abroad, Martin noted that probably more foreign dealers and other visitors have come to the company's Wichita plant the past two years than in the previous decade.

To maintain these close ties Cessna is immediately putting a full-time service representative on assignment to work with its European area dealers, to aid them in setting up facilities and solving problems. The man assigned to this duty will be based at the factory, and spend some 60% of his time traveling abroad. The company believes this system will prevent the man from losing touch with the latest developments and will keep him from getting stale. A full time sales representative will also be assigned to cover the area.

Meeting in Nice

A big problem in developing additional interest in the company's products is that as yet few airplanes are being used in the area, subsequently there are many prospects who have never even seen one of its airplanes. This was particularly pointed up during a tour made with the 310C demonstrator, following the meeting in Nice which has logged some 200 hr. at taking interested prospects and local prominent persons aloft. Indications are that a number of 310 sales directly attributable to these showings will result. Martin ventured that as a result of the trip to Europe, Cessna can expect to double its 310 sales this year in that area compared with total sales in the past five years.

In order to maintain this exposure, he stated that the company representatives assigned to foreign sales and service in the future will take along different airplanes of the various models for their use as they tour the areas.

Members who attended the export conference abroad expect that it will have the same impact in developing the dealer organization that has been experienced following a similar meeting

— the South American area numbers of outlets increased as a result of attendance at the sessions, information exchange resulted in dealers developing their facilities and expanding their services, and team spirit engendered at the meetings led to greater cooperation among dealers with benefits to all. Concrete results of the past year's meeting could be noted during each succeeding visit Martin stated. Enthusiasm reported among the dealers at the Nice meeting indicated that similar facilities expansion will be undertaken in the year to come.

As an example of how the meeting helped expand the sales outlet problem in Europe, Martin noted that now the company's Athens sales representative plans to expand his facilities and become a full-fledged dealer. He forecasts that if this man follows through on plans he outlined during the meeting he may become a distributor. As an indication of the progress this spells in that area, Martin noted that the company has never sold in Greece—facilities have been so lacking that arrangements had to be made for an airline pilot to teach the sales representative to fly. The country has a good potential, indicated during the 310 demonstration flights made in Athens when 150 200 top people in the city were given rides.

$89,950 FOR Pace Gannet amphibian includes communications-navigation package

Radial Engines Power Widgeon

Burbank, Calif.—Production program for a six passenger modification of the Grumman Widgeon amphibian powered by 300 hp radial Lycoming engines, has been established by Pacific Aircraft Engineering Corp. (Pace) at Lockheed Air Terminal here.

The Pace conversion provides the airplane with a cruise speed of 170 mph at 66% power at 8,000 ft with gross weight of 5,500 lb., the company reports. Other prime performance characteristics include 10-sec. takeoff from water at full gross weight and climb of 1,850 fpm. and single-engine ceiling at this weight of 8,000 ft.

Price of the equipped conversion, incorporating some 34 major refinements,

Pace Gannet

Gross weight	5,500 lb
Useful load	1,700 lb.
Maximum speed (sea level)	190 mph.
Cruise speed (66% power @ 8,000 ft.)	170 mph.
Rate of climb (sea level)	1,850 fpm.
Landing speed (gross weight)	62 mph
Water takeoff time (gross weight)	10 sec
Single engine ceiling (gross weight)	8,000 ft
Fuel capacity	158 gal.
Range	1,000 mi.

and standard equipment including instrument flight panel, is $89,950. Panel installation includes a Lear Navcom 100, Lear Navpak 100 and Lear ADF-12 with gonio indicator and gonio type antenna.

Present schedule calls for converting 15 Pace Gannets from zero-time French built SCAN 30 Widgeons, the company also has a program to convert existing Widgeons to Gannet configuration in 30 days, according to Vice President-General Manager Charles H. Harris.

Modification program includes rebuilding the existing hulls by installation of five watertight compartments, two longitudinal steps in the hull, new uplock mechanism for main and tail landing gears, escape hatch and new hydraulic and electrical systems. Electrical system has 50-amp generator and booster coil for cold starts. Entire trailing edges of the wings are removed and replaced with new ribs. Wings are all metal covered and flush riveted. Auxiliary fuel tanks of 25-gal. capacity are located in the wings.

Lycoming R-680-E3 powerplants are fitted with pressure cowlings with over-the-wing augmented exhausts. Engine modifications include straight-through push rod housings and revised nose cones with new engine crankcase venting systems. Engines have chrome plated cylinders and Neoprene-covered ignition harness. Oil system provides two six-gallon vented tanks. Propellers are three-blade Hartzell full feathering types.

Beech Designs Modernization Kits For Super 18s, D18Ss and C-45s

Wichita, Kan.—Important performance gains are realized in early model Beech Super 18 and Model D18S and C-45 versions as a result of specially developed factory supplied kits available now through the company's distributor-dealer organization.

Refinements developed by Beech engineers can be installed individually, in combination according to the owner's wishes, or as a complete package to provide maximum modernization. Kits are approved by Federal Aviation Agency.

• **Super 18 modernization** kit significantly increases early model E18S performance in every category and brings it up to par with new Super 18 production models, including gross weight of 9,700 lb. (AW Dec. 8, 1958, p. 112).

• **Model D18S** and military versions can have gross weight boosted to 9,000 lb., cruise speed increased more than 20 mph., METO (maximum except takeoff) power increased from 400 hp. to 450 hp., two engine rate of climb increased by 310 fpm. (single-engine climb is up 204 fpm.), service ceiling increased by 4,100 ft. (single-engine service ceiling by 3,700 ft.). Increases reportedly are based on data furnished by customers who already have had this kit installed. Some of the modifications for the basic Model 18 include new features incorporated on 1959 model Super 18s.

Hartzell three-blade propeller kit, which replaces two-blade Hamilton Standard propellers, is priced at $5,975 with anti-icing provisions and $5,725 without this latter equipment. Propellers, Model HC/B3230-2D/10160-B-6 are especially designed to Beech requirements and feature heavier, 10% thicker blades than previous Hartzell three-blade propellers, some of which have been installed at modification centers prior to the Beech-approved kit. Thicker blades were felt to provide the ruggedness needed when drawing full power out of the Twin Beech's 450 hp. Pratt & Whitney R1340 engines—in other feature is that they use ball bearing type retention in the hub compared with the previous splitring retention system on earlier Hartzell three-blade props. Three-blade prop installation also provides some 40% reduction in vibration in cabin area compared with the Hamilton Standard installation, noticeable lowering of noise and reduced crankshaft stresses.

Additional Items

Other items in the Beech modernization kits include:

• **Jet stack installation** ($4,275), triple tube type reducing manifold back pressure and pulling more air over the engine to provide extra cooling.

• **Carburetor ram air scoops** ($1,090) which provide increased manifold pressure to allow more power. Ram air pressure is increased at the carburetor deck, decreasing the amount of thrust horsepower used to operate the supercharger. A new mixture valve is designed to reduce valve icing.

• **New cabin heating systems**: a super 90,000 Btu. janitrol installation for the right wing or a layout of two 40,000 Btu. units with Stewart-Warner heaters mounted in the wheel wells. Both systems have defrosting equipment and blowers for ground operation. Big single unit is priced at $5,640 and the dual system at $2,995.

• **Super 18 landing gear doors** permit

BEECH 18 has three-blade Hartzell propellers and Beech-developed kits installed

ting extension of gear at speeds up to 160 mph are priced at $1,200

• **Stabilizer angle** of incidence change reduces angle from −2 deg. to −½ deg., adding three to six miles per hour to airplane's speed through drag reduction. Additional aerodynamic stability is provided by installation of an elevator down spring. Cost of change is $340

• **Fuel flow meter,** making possible most economical and effective power settings, is available at $1,425

• **New cowl bracket supports,** aimed at reducing effects of engine vibration and fatigue problems. Cost of this equipment is $45

• **Improved oil radiator** cooling air valve, permitting complete air shut off over the oil radiator to facilitate cold weather engine warmup, is priced at $8

Optional kits also include revised nose to Super 18 configuration, with removable access panel. Price is $1,200. Wingtip extensions are also available, permitting improved rate of climb, decreased stall speed and more effective aileron control ($1,330), 60-gal. auxiliary wing tanks, freeing nose section for radar and radio installations ($2,995), extended tail wheel raises ground height six inches to provide easier landings, improved visibility and ground handling characteristics, also levels the cabin floor to provide more comfort for passengers while plane is on the ground ($680), leading edge landing lights, including lower intensity taxi light ($295) and new engine crankcase vent, which reduces possibility of freezing and clogging of vent and vent lines ($215)

Basic Kit

Basic kit for modernizing early Super 18s comprises new propellers, carburetor ram air scoop and auxiliary wing tanks.

New powerplants, providing increased reliability and performance, will be installed in a new model of the Cessna T-37A jet trainer in November. Installation of the later engines and revision of airplanes' current avionic equipment to improve navigation and communications facilities (AW Nov. 24, 1958, p. 113) will result in later production models being designated T-37B.

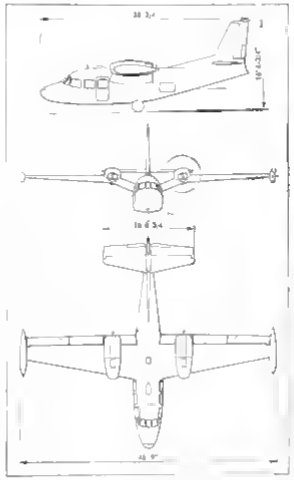
First phase of program, installation of new avionics gear, starts in June, new 1,050-lb. thrust Continental J69-T-25 turbojets will be fitted starting in November at which time the airplane will receive its new designation. J69-T-25s are expected to provide reduced maintenance and longer engine life than current 920-lb. thrust J69-T-9s.

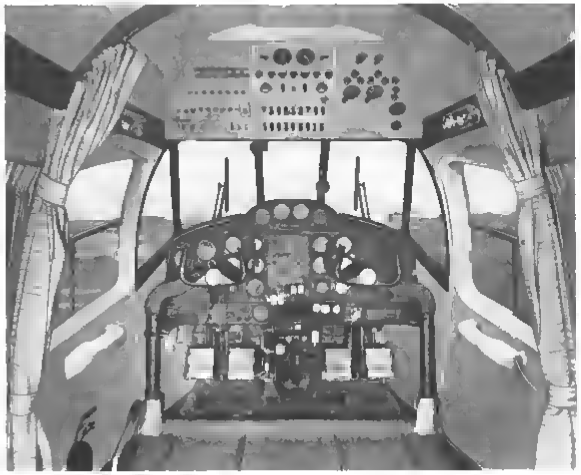
Installation of new engines does not require major modifications, Cessna reports.

Trecker 166 executive transport is fitted for JATO. Range is about 1,200 mi. Three-blade propellers are full-feathering.

First Trecker 166 Sold to Drilling Company

First Trecker 166 twin-engine executive plane, an adaptation of the Trecker Gull amphibian, has been delivered to Drilling Tools Inc., Houston, Tex. Aircraft is a version of the Italian Piaggio 136 and is powered by two supercharged Lycoming engines rated at 340 hp. each. Six-place plane is priced $114,500 at the factory. The airframe is built by Piaggio & Co. at Genoa, Italy, assembly and installation of the pusher engines, instruments and mechanical components is completed at Trecker Aircraft Corp.'s facility at General Mitchell Field, Milwaukee, Wis. Initial production involves 20 planes.



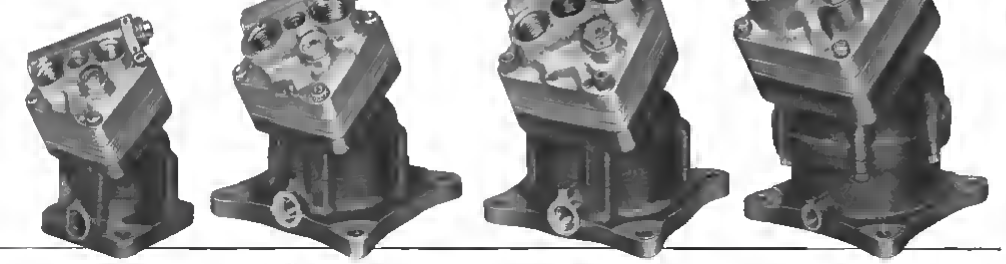


Aircraft's nose cowl is removable for instrument and radio repair. Pilot's compartment has separate door at right.

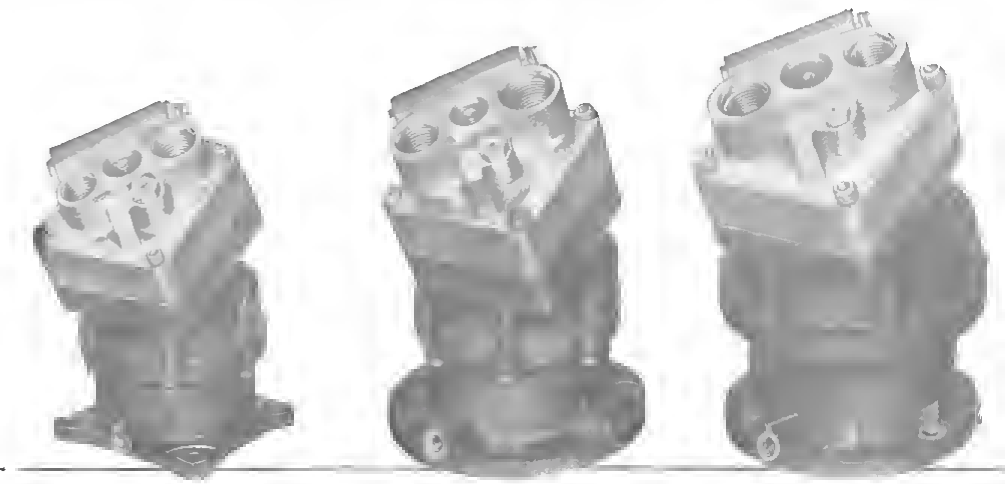
Design breakthrough now in depth!

VICKERS. ADVANCED DESIGN VARIABLE DISPLACEMENT PUMPS

(PV SERIES)



Model Series	PV006	PV012	PV024	PV039
Theoretical Dspl	.095 cu in./rev	.188 cu in./rev	.367 cu in./rev	600 cu in./rev
Rated Speed	12,500 rpm	10,000 rpm	8,000 rpm	8,000 rpm
Weight	2.4 lb	4.2 lb	5.9 lb	9.5 lb
Hp/lb @ Rated Speed	3.8	3.4	3.8	3.8
Bolt Spacing	1.875"	3.536"	3.536"	3.536"
Overall Length	4⅜"	5⅞"	5¾"	6 13/32"



Model Series	PV052	PV104	PV153
Theoretical Dspl	550 cu in./rev	1,600 cu in./rev	2,350 cu in./rev
R		*	*

Similar inherent performance advancements shown for the smaller pump sizes will be carried over to these models.

• "Design breakthrough" as used on this page is a carefully considered statement. Here is the lineup of the PV series fixed angle variable displacement hydraulic pumps for aircraft and missiles systems optimization. The numerous important improvements briefly discussed at the right indicate that these advanced design pumps are destined to set new standards of performance.

All series have integral automatic pressure compensator and a broad range of control methods. This advanced design requires substantially fewer parts than conventional design . . . and it has reduced to a minimum the number of external sealing elements. Now, for the first time, the power saving (and heat rejection) advantages of variable displacement are available in pumps of fixed displacement envelops and weight.

When first announced last March, only the smallest unit (Series PV006) had completed exhaustive endurance tests and was available. Now three more series (PV012, PV024 and PV039) are ready for system application. Three larger sizes are in the development stage. *For further information write for Bulletin A-5233.*

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulics Division • Engineering, Sales and Service Offices:

ADMINISTRATIVE and ENGINEERING CENTER | TORRANCE CALIFORNIA • 3221 Lomita Boulevard
Department 1462 • Detroit 32, Michigan | P.O. Box 2003 • Torrance, California

Aero Hydraulics Division District Sales and Service Offices

Albertson, Long Island, N.Y. • Arlington, Texas
Seattle 4, Washington • Washington 5, D.C.

Additional Service Facilities at: Miami Springs, Fla.

IMPROVED LIFE

Exhaustive endurance tests have proved these new pumps meet the requirement of new MIL-P-19692 specification (i.e., 750 hours at rated rpm which is a very substantial increase over the 560 hours previously required).

INCREASED SPEED CAPABILITIES

The maximum recommended speeds (both continuous and intermittent) have been greatly increased for all sizes without exception . . . more than doubled for some models.

SAME HIGH EFFICIENCY

Volumetric efficiency is from 96% to 98% over a pressure range of 500 to 3000 psi. All the improvements enumerated here have been made without any sacrifice of the exceptionally high efficiency inherent in Vickers axial piston type pumps . . . under partial as well as full flow conditions.

IMPROVED RESPONSE

The PV006 series is capable of full flow to zero flow response in 0.02 sec and zero flow to full flow response in 0.04 sec without pressure oscillation.

MINIMUM PACKAGE

These PV series variable displacement pumps have practically the same envelope as constant displacement units of equal output. In comparison with standard variable pumps, the reduction in envelope varies from 70% to 15% as size increases.

IMPROVED CONTAMINATION RESISTANCE

Performance of these new pumps is greatly improved even when operating with contaminated oil. This improved contamination tolerance results from changes in both design and materials.

IMPORTANT WEIGHT SAVING

The new advanced design pumps represent a 100% increase in power-to-weight ratio over any other variable displacement pumps now available. The magnitude of this improvement is evident from the fact that every added pound of component increases a missile's gross weight from 30 to 75 pounds.

IMPROVED RELIABILITY

Exceptional capabilities (high speed, long life and contamination tolerance) under extreme conditions . . . even greater under normal application.

PARTS STANDARDIZATION

Major parts are interchangeable for fixed and variable displacement pumps and for fixed and variable motors in each series. This standardization results in customer savings.

†PATENTS PENDING

6118

PRIVATE LINES

Credit service for private and business pilots, developed by American Express Co., permits charging aviation gas, oil, parts, maintenance, plane charter and other services. First aircraft service operation to join the credit card plan was Newark (N. J.) Air Service. New service now is part of comprehensive Amex credit card providing hotel accommodations charges, as well as meals, entertainment, car rental, telegrams and other features.

Largest single government-sponsored airborne magnetic survey ever carried out in Canada has been awarded Spartan Air Services, Ltd., Ottawa, by Province of Ontario's Department of Mines. The $400,000 survey will cover some 60,000 sq. mi. of Northern Ontario and Spartan will use two Cessna 310 aircraft for the job. Planes will carry a new Varian nuclear precession type magnetometer, which records data on punched tape and graph paper.

Kellett Cropduster autogiro has received Federal Aviation Agency Type Certificate. Aircraft followed original prewar Kellett design so closely that it was recertificated with same TC number, 712.

Mobile field X-ray inspection service, designed for use at any business or private aircraft operator's base, has been inaugurated by Lockheed Aircraft Service-New York International Airport. Unit provides non-destructive testing and inspection without need to disassemble airframe to get at otherwise inaccessible areas.

Private plane tour, sponsored by Philadelphia Junior Chamber of Commerce, will be held from Las Vagas, Nev., to Philadelphia Aug. 8-13. Single- and twin-engine aircraft are eligible. Entrance fee is $30. Contact Junior Chamber of Commerce at 121 South Broad St., Phila. 7, Pa.

Airplane Financing

Wichita, Kan.—Financing of new airplanes for Cessna Aircraft Co. dealers will run at the rate of approximately $1 million monthly for this fiscal year, according to National Aero Finance Co., the manufacturer's wholly-owned subsidiary. Nafco probably will process approximately 1,000 aircraft on floor plans for the Cessna dealer organization in Fiscal 1959, accounting for some 30% of airplanes delivered to sales outlets. Last year the finance company handled approximately 900 airplanes.

Aerial Photo Duplicated by Xerography

Aerial reconnaissance print, utilizing a xerographic duplicating process, can be finished 22 sec. after exposure of an aerial photographic negative. Printer, developed by Haloid Xerox, Inc. under Air Force contract, produces 9 x 9 in. prints in 2½ sec. from aerial roll negatives. Actual prints have a sepia cast.

Navy Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Navy Contracting Offices.

AVIATION SUPPLY OFFICE, 700 Robbins Avenue, Philadelphia 11, Pa.

The Goodyear Tire and Rubber Co., Akron, Ohio, wheel assemblies, nose, for A3D aircraft, N383-59783A(383/211243-59) 136 ea., $51,428.

Douglas Aircraft Co., Inc., El Segundo, Calif., services and materials to restore to ready-for-issue condition to the latest Navy approved configuration, gyro controls, roll rate, N383-57980A(383/212171/59), $228,393.

Flightex Inc., New York, helmets, flight deck crew, sound attenuating, N383-58127A (IFB-383-31-59) 11,664 ea., $71,973.

Gaunry Bros., Mt. Ephraim, N. J., tension bars, catapult holdback, for launching various aircraft, N383-57192A(IFB 383-173-59) $111,748.

M. Steinthal & Co., Inc., New York, parachute assemblies, back type, N383-59408A (IFB-383-146-59) 870 ea., $133,997.

Rubbercraft Corp. of America, Inc., West Haven, Conn., life rafts, pneumatic, for aircraft use, N383-58111A(383/221017/59 383/271111/59) $142,865.

Pioneer Parachute Co., Inc., Manchester, N. H., parachute assemblies, back type, N383-59007A(IFB-383-140-59), 759 ea., $114,250.

Vickers Inc., Detroit, Mich., repair kits to support hydraulic pumps on various aircraft, N383-57958A(383/213220/59), $12-614.

Hydraulic Research and Manufacturing Co., Burbank, Calif., valves, hydraulic for various aircraft, N383-58755A(383/214115/59), $33,991.

Texas Instruments, Inc., Dallas, Tex., meter movements to support sonar equipment, N383-58825A(383/222253-59), 385 ea., $83,875.

Flexco Inc., Huntington Park, Calif., hoses, air duct for various aircraft, N383-57704A(383/217278-59), 3,180 ea., $27,469.

Barber-Colman Co., Rockford, Ill., controllers, cabin air temperature for F4D-1 aircraft, N383-57706A(383/212182-59) $556,359.

Aviators Equipment Corp., Beacon, N. Y., life rafts, inflatable, one person capacity N383(MIS)58882A(MIPR 00 003 09-4220 78), 20,721 ea., $1,146,394.

United States Rubber Co., Passaic, N. J., hose, rubber, aircraft, hydraulic, pneumatic, fuel and oil resistant, N383-58996A(IFB 383-385-59) $45,578.

B. F. Goodrich Industries Co., Division B. F. Goodrich Co., Akron, Ohio, hose, rubber, aircraft, hydraulic, pneumatic, fuel and oil resistant, N383-58994A(IFB-383-385-59) 115,036 ft., $41,983.

The Lewis Engineering Co., Naugatuck, Conn., indicator, temperature, thermocouple for various aircraft, N383-58930A(IFB 383-388-59) 1,286 ea., $48,417.

Government Contract Sales Division, Dow Chemical Co., Midland, Mich., dichloromethane, technical, for use in preparation of acrylic resin plastic cement, paint removers and safety solvents, N383-59970A(IFB-383-538-59) $82,810.

Green River Steel Corp., Owensboro, Ky., steel bars, chrome-molybdenum normalized round, N383-58934A(IFB 383-514-59) 382,226 lb., $50,945.

Parker Aircraft Co., Los Angeles, Calif., valves, main, to support hydraulic systems for various aircraft, N383-56323A(383/214150/59) $84,820.

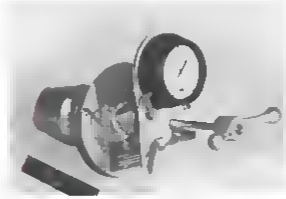
NEW AVIATION PRODUCTS

Transport Tow Tractor

Jet transport tow tractor is capable of traveling with a load at speeds of 26 mph.

Tractor, powered by a Chrysler 260-hp industrial engine, has a 30,000 lb drawbar pull. A drawbar hitch at either end of the vehicle permits towing in either forward or reverse gear.

Silent Hoist & Crane Co., 63rd St., Brooklyn 20, N. Y.



Reception Coupling Tester

Coupling tester is used for ground checking of engaging and disengaging forces between aerial refueling equipment.

Aluminum MA-2 pull-off tester is manually inserted into the tanker aircraft's reception coupling to check the toggle tension and pull-off load forces. Forces are recorded on a closed hydraulic circuit.

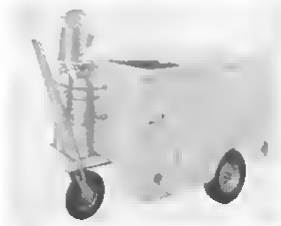
Flight Refueling Inc., Friendship International Airport, Baltimore, Md.

Jet Accessories Tester

Major accessories test stand, designed for jet transport operators, tests fuel controls, fuel pumps, pressurization and dump valves and other subassemblies of Pratt & Whitney JT3 and JT4 engines.

Model 8893 test stand uses a high pressure variable speed pump to schedule fuel flow to the fuel control inlet. Variable speed drive holds speed within ½% of set speed with a load change of 0 to 100% over a speed range of 500 to 4,000 rpm. Flowmeter ranges are 215 to 36,000 pph or ±½% for metered flow and for low return flow, 19 to 3,120 pph plus or minus 1%. Vacuum pump to simulate high altitude is capable of maintaining 29 in. of mercury vacuum continuously.

George L. Nankervis Co., 15400 Fullerton Ave., Detroit 27, Mich.

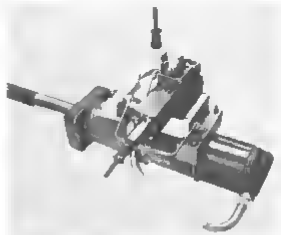


Freon Service Cart

Service cart is intended for line and overhaul servicing of Freon refrigeration systems of commercial jet transports.

The cart will recharge both Freon and lubricating oil and evacuate the Freon system to 100 microns or less. Dehydration and filtration of Freon and lubricating oil is achieved with a dessicant and 3-5 micron filters. Available as an option is a leak detector. The cart can be modified to meet customer requirements.

Kahn and Co., Inc., 541-549 Windsor St., Hartford 1, Conn.



Electro-Hydraulic Actuator

Actuators are designed for accurate positioning of rocket nozzles, aircraft guidance simulators, wind tunnel models and deflecting walls. Positioning systems are capable of 8 fps speeds on a 4 in. cylinder with accuracy better than 1 part in 2,000.

Positioners are available in a range of from 1 to 500 hp and operate at pressures to 3,000 psi. Frequency response is flat up to 19 cps in large capacity systems, and up to 50 cps in smaller systems.

CompuDyne Corp., 451 S. Warminster Rd., Hatboro, Pa.

Missile Rate Gyros

Miniature fluid-filled rate gyros are designed for flight control systems of both aircraft and missiles.

Gyros, operating in a temperature range of from −65 to +185F, are single degree-of-freedom, viscous damped spring restrained (torston bar) types. The maker says that the use of compensatory damping mechanisms obviates the need for accessory heaters thus reducing weight and volume. Units having weights from 45 to 1,000 deg per second, are available.

Kearfott Co., Inc., 1500 Main St., Clifton, N. J.

Ultrasonic Vapor Degreaser

Degreaser, designed for the Air Force, cleans aircraft engine and instrument components including oil and fuel strainers, pistons and rings, valves, bearings and pumps.

Components are placed first in a boiling solvent, then in an ultrasonic cleaning tank, flushed with a solvent spray and left in the vapor which dissolves any trace of grease or carbon. The maker says that the unit requires 1/40 the time of manual cleaning methods.

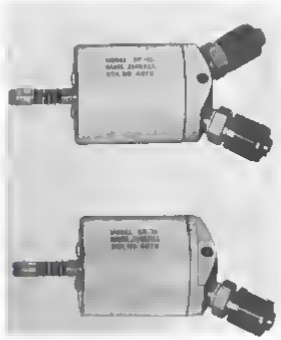
Narda Ultrasonics Corp., Westbury, N. Y.

Pressure Transducers

Pressure transducers intended for jet and rocket engine testing are designed to resist effects of corrosive liquids and gases.

Model GP-15D is a miniaturized

unit said to be resistant to mechanical shock and vibration. It is available in ranges from 10 to 6,000 psig. Model DP 15D, a differential pressure transducer incorporating dual bleed screws,



is available in ranges from + or − 5 to + or − 5,000 psi differential at line pressures to 5,000 psi. Both units are constructed of type 416 stainless steel to achieve high strength and resistance to the corrosive liquids and gases associated with rocket testing. **BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.**

Synchro Instrument Tester

Test kit is designed for field testing of aircraft synchro-transmitter/indicator systems. Kit is intended primarily for operators of jet transport aircraft. Model TE 2A synchro test stand and combines four instruments: an a-c voltmeter for checking aircraft voltage, a master indicator for checking synchro-transmitters, a master transmitter for checking synchro indicators and a transformer for checking electrical zero of synchro-indicators. Test unit weighs 10 lb., is contained in an aluminum case measuring 8 x 9 x 16 in. **U. S. Gauge, division of American Machine and Metals, Inc., Sellersville, Pa.**

WHAT'S NEW

Telling the Market

Description of a packaged light source for recording high-speed phenomena with shadowgraph and schlieren systems, bulletin, Marketing Department, M-3, Research and Advanced Development Division, Avco Manufacturing Corp., 201 Lowell St., Wilmington, Mass. Flow-rate pressure drop curves, cross-section drawings and installation drawing of No. 565383 replacement elements for aircraft main fuel line filters, engineering data sheet No. 102, Bendix Filter Division, Bendix Aviation Corp., 434 West 12 Mile Rd., Madison Hgts., Mich.

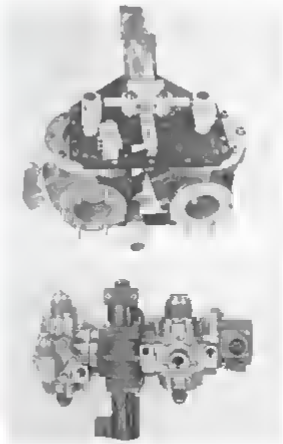
Illustrated description of polyvinyl-insulated, multi-conductor cable for installing six to 56 pairs of thermocouple leads at one time, Catalog 33, Thermo Electric Co., Inc., Saddle Brook, N. J.

Electrical and mechanical characteristics and drawings of all types of synchros and rotary components, catalog, Clifton Precision Products Co., Inc., 9014 West Chester Pike, Upper Darby, Pa.

No. 1 and 2 of a series of new literature on ideas for die protection, Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Uses and descriptions of precision, pressure-sensitive tapes and symbols for master drawings in printed circuitry, folder, Chart-Pak, Inc., One River Rd., Leeds, Mass. Method of operation, dimensions, materials of construction, and optional features of Deltadyne differential pressure indicator, Bulletin A-109, Aircraft Porous Media, Inc., 30 Sea Cliff Ave., Glen Cove, N. Y.

Specifications, performance data, application information and optional features of solenoid valves, Catalog 444, Atkomatic Valve Co., 545 West Abbott St., Indianapolis, Ind. Presentation of engineering facilities for the design and manufacture of automatic wide-band countermeasures, special equipment and complete systems, brochure, Instruments for Industry, Inc., 101 New Smith Rd., Hicksville, N. Y. A Guide to Fire Extinguishers, folder, Fire Equipment Division, Ansul Chemical Co., Marinette, Wisc.

Application, engineering data, performance curves and dimension drawings of accessory equipment for aircraft, missile and spacecraft, catalog, Lyndon Aircraft, Inc., 140-16 Clifford St., Newark 5, N. J. Re-Usable Steel and Aluminum Shipping Containers for parts and components of electronics, air



X-15 Propellant Valves

Valves for the liquid fueled engine of the North American X-15 hypersonic research aircraft include the main propellant valve (top) and intermediate stage dual propellant valve. Ball valves meter liquid oxygen and ammonia to the Reaction Motors engine at rates of 10,000 lb /min. Flo-Ball valves are produced and manufactured by Hydromatics, Inc., Livingston, N. J.

craft, atomic equipment, missiles and rockets, illustrated brochure, DeVilbiss Metal Fabricators Co., 5741 Russell St., Detroit 11, Mich.

Technical description of **miniature magnetic tape recorders for airborne applications**, five instrumentation bulletins, BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif. Applications and specifications of Model 502 **AC-DC digital voltmeter**, Data Sheet No. 19.41, Kin Tel, Cohu Electronics, Box 623, San Diego, Calif. Selection charts, graphs, and mechanical and electrical properties of **AlSiMag ceramics**, Chart No. 591, American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn.

Applications, functions, specifications and operating characteristics of **valves, strainers, filters, etc., for aircraft and missiles**, catalog, Kochler Aircraft Products Co., 409 Leo St., Dayton, Ohio. Illustrated description of **commercial jet engine test stands** and other test equipment, Catalog No. 1383, George L. Nankervis Co., 15400 Fullerton Ave., Detroit 27, Mich.

Photographs, block diagrams, outline drawings, and specifications of Model 2HLA-4a **D-C amplifier with isolated differential input**, Catalog B-C2HLA-4, Minneapolis-Honeywell, Boston Division, 40 Life St., Boston 35, Mass.

Key information on **linear motion potentiometers, pressure transducers, accelerometers and angular position transducers**, Instrument Summary Brochure—March, 1959, Bourns Laboratories, Inc., P. O. Box 2112, Riverside, Calif.

Gaseous Oxygen Laboratory Tests Critical Missile Equipment, illustrated brochure, A. L. Spangenberg, Director of Engineering Laboratories, Whittaker Controls Division of Telecomputing Corp., 915 North Citrus Ave., Los Angeles 38, Calif.

Publications Received:

Van Nostrand's Dictionary of Guided Missiles and Space Flight—by Grayson Merrill, Capt., USN (ret.)—D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. $17.50, 688 pp. Dictionary defines and explains most commonly used terms in the guided missile and space flight field today.

Magnetic Amplifier Engineering—by George M. Attura—McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. $7.50. 220 pp. A basic guidance on magnetic amplifiers.

Civil Test Planned Of Runway Barrier

New York—First civil aviation evaluation of runway arresting barriers begins this month at the Federal Aviation Agency's National Aviation Facilities Experimental Center, Pomona, N. J.

The six-month program, to be conducted by All American Engineering Co. under a $125,000 FAA contract, will test the effectiveness of the company's runway barriers in engaging the main landing gear of jet transport aircraft.

A truck-powered full scale mockup of a jet transport landing gear, including stub wings and landing gear pods will engage the barriers at speeds to 60 mph.

Two types of runway barrier will undergo test. The first barrier, All American's Model 56, utilizes a trigger cable which, when engaged by the nosewheel, raises the 1¼-in. diameter arresting cable above the tires to snag the main landing gear struts.

The second barrier to be tested will utilize a pneumatic system to raise the arresting pendant.

In other tests, an Air Force Convair C-131 transport will be fitted with a belly hook for tests of the arresting engine itself.

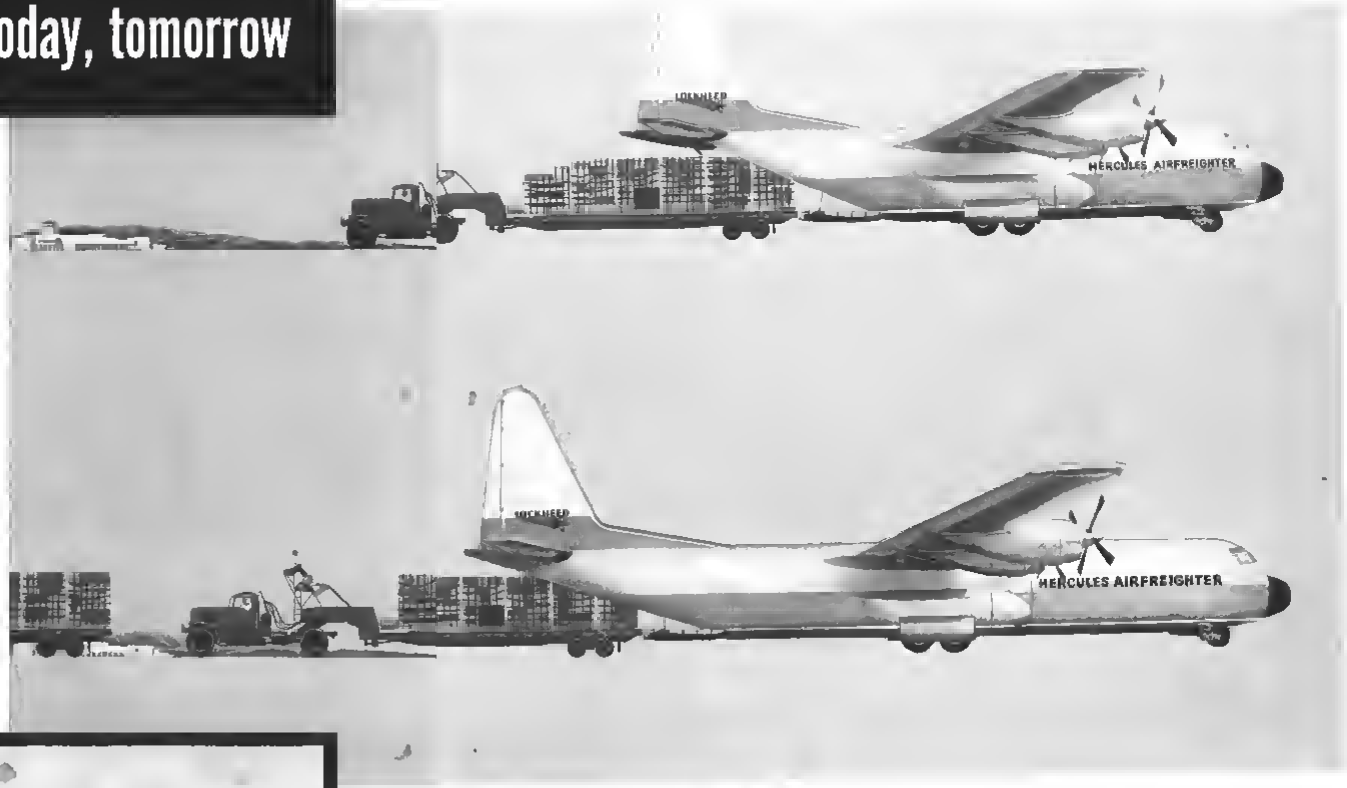
Lockheed's HERCULES Airfreighters –
Your profit-partners: today, tomorrow

Designed to haul the goods of the world in the Jet Age, the Lockheed HERCULES Airfreighter has a profit-making edge over any other cargo hauling aircraft now flying.

One important advantage is the Lockheed-developed Lightning Loader system. With it you can winch 22 tons of palletized cargo in or out of a HERCULES Airfreighter in only 40 seconds!—saving hours of ground time.

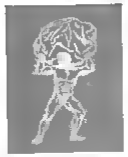
Looking ahead to the time when air cargo volume demands more payload capability, Lockheed again has the answer—the bigger, longer-ranged SUPER-HERCULES Airfreighter, which can bring direct operating costs down below 4 cents per ton mile. And pay you a handsome profit doing it.

To compete for air cargo profits today, the HERCULES is your best buy. Then, when your volume warrants it for your heavy volume, long range routes, add the new SUPER-HERCULES Airfreighters—retaining the HERCULES on other routes to give you a completely integrated operation.



Map compares cross-country flights of Prop-Jet HERCULES Airfreighter, using Lightning Loader system, and fastest type piston-engine cargo transport. Both leave New York with identical 20-ton cargoes, make same en route stops, unload and reload identical cargo at each stop. By the time piston engine plane arrives in San Francisco the Lockheed HERCULES Airfreighter has reached Chicago on return trip.

Over-the-weather capability of the HERCULES Airfreighter is an important profit-making plus. "On time" deliveries of air cargo keep today's customers happy, build air freight volume and profits for the future.



TOP ILLUSTRATION: **Today's HERCULES Airfreighter,** using Lockheed's Lightning Loader system, can land, unload entire 6-pallet, 22-ton payload, reload, and take off—in less than 20 minutes time!

BOTTOM ILLUSTRATION: **Tomorrow's SUPER-HERCULES** Airfreighter has 23-foot longer fuselage, greater wingspan, maximum 10-pallet, 39-ton payload capability—plus same Lightning Loader system.

LOCKHEED

JET TRANSPORTS • JET FIGHTERS • JET TRAINERS • COMMERCIAL & MILITARY PROP-JET TRANSPORTS • ROCKETRY
BALLISTIC MISSILE RESEARCH & DEVELOPMENT • WEAPON SYSTEM MANAGEMENT • ANTI-SUBMARINE PATROL AIRCRAFT
NUCLEAR-POWERED FLIGHT • ADVANCED ELECTRONICS • AIRBORNE EARLY-WARNING AIRCRAFT • AIRPORT MANAGEMENT
NUCLEAR REACTOR DESIGN & DEVELOPMENT • GROUND SUPPORT EQUIPMENT • WORLD-WIDE AIRCRAFT MAINTENANCE

WHO'S WHERE

(Continued from page 23)

Changes

R. J. Pfeiffer, manager commercial aircraft marketing, North American Aviation, Inc., Los Angeles, Calif.

T. J. Sullivan, assistant division manager contracts, customer service and material, Convair (San Diego) Division of General Dynamics Corp., San Diego, Calif. **William T. Alva** succeeds Mr. Sullivan as manager of contracts at Convair's Ft. Worth, Tex., plant.

Edward N. Skomal, solid state marketing specialist, Motorola Electronics Division, Phoenix, Ariz.

Derek J. Whitehead succeeds **Tim Wood**, retiring, as chief test pilot, Blackburn & General Aircraft, Ltd., East Yorks, England.

Robert O. Briggs, chief engineer, Electronics Division, United ElectroDynamics, Inc., Pasadena, Calif.

Edwin D. Eaton, manager of the newly created specialized ground support equipment department of Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn. Other appointments: **Raymond P. Lambeck**, chief of preliminary design and sales, **Wilson M. Alford**, development engineer, **Harold Rourke**, chief of ground support equipment production, **Sherwood V. Martin**, administrative assistant. **Vernon E. Hupp** succeeds Mr. Eaton as Hamilton Standard's chief of experimental operations.

Louis A. Wayne, manager, Engineering Division of the Astronics Division, Leach, Inc., Santa Monica, Calif.

Anatole Browde, department manager, advanced systems planning department, Electronics Departmental Group, Missile Engineering Division, McDonnell Aircraft Corp., St. Louis, Mo. Also **Matthew A. Lafer**, section manager, mechanical design and developmental services, Electronics Department, Central Group.

Michael Dodak, director of marketing, Arnoux Corp., Los Angeles, Calif.

Hughes Aircraft Co., Culver City, Calif., has established Far East and European offices and made the following appointments: **Edwin F. Ramsey**, in charge of Far East Operations, Tokyo, Japan, **George E. Todd**, in charge of European Operations, Paris, France.

Northrop Corp., Beverly Hills, Calif., has established a corporate district office at San Antonio, Tex., and appointed **Arvid E. Olson, Jr.**, manager.

Edward Waldman, general manager, and **George Brown, Sr.**, chief engineer, Telectro Industries Corp., Long Island City, N. Y.

David D. Munro, III, manager, electrical and electronic laboratories, Commonwealth Engineering Co., Dayton, Ohio.

Thompson Ramo Wooldridge Products Co., Los Angeles, Calif., has established European and Eastern United States sales engineering offices and made the following appointments: **Willard A. Bridges**, head of the European office, Paris, France; **Richard M. Hexter**, head of the Eastern U. S. office, New York, N. Y.

Joseph B. Tate, manager, Military Electronics Division, Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc., Houston, Tex.

Jack Winslow, administrative assistant to the vice president engineering program development, Technical Products Division, Waste King Corp., Los Angeles, Calif. Also **Robert L. Potter**, manager manufacturing services department, **James L. Lecka**, technical representative.

Frank R. Demchock, assistant director of customer relations, Chicago Aerial Industries, Melrose Park, Ill.

Otis F. Bryan, manager of airline sales, Link Aviation, Inc., Binghamton, N. Y.

William P. Novack, supervisor manufacturing engineering, and **Carlyle Moore**, manager technical reproductions, Technical Products Division, Packard Bell Electronics Corp., Los Angeles, Calif.

James A. Doherty, director of quality control, Sunnyvale Gyroscope Co., Santa Monica, Calif.

Robert W. Landee, director of research and development for airborne data communication, Western Division of Collins Radio Co., Burbank, Calif.

Charles N. Hood, II, director of engineering, Airborne Accessories Corp., Hillside, N. J.

Edward N. Gomberg, general manager, Consolidated Diesel Electric Corp.'s Western facility, Los Angeles, Calif.

CAB Accident Investigation Report:

Pilot Error Blamed for Nantucket Crash

About 2334[1] Aug. 15, 1958, Northeast Airlines Flight 258 crashed during an instrument approach to the Nantucket, Mass., Memorial Airport. The crew of three and 22 of 31 passengers received fatal injuries. The nine surviving passengers were seriously injured. The aircraft, which burned after impact, was destroyed.

The accident occurred during a straight-in VOR (very high frequency omni range) instrument approach to runway 24 (240 deg.). An analysis of all the available evidence indicates that the approach was continued after receipt of a below-minimum visibility report.

At low altitude in the area of the H[2] facility (a low-power nondirectional radio beacon), the flight encountered heavy fog in which the pilot lost orientation and ground reference. The aircraft contacted the ground almost simultaneously with the initiation of an attempt to discontinue the approach.

The accident investigation and public hearing by the Board and an operational inspection of the company by the Civil Aeronautics Administration[2] (CAA) disclosed discrepancies which reflected adversely on some of the policies and procedures of the company and on the adequacy of the implementation of these policies and procedures. These criticisms are stated in the body of this report.

Through communications with company officials and the Administrator, the Board has been informed that positive steps have been taken by the company to eliminate the deficiencies and that rapid and substantial progress has been made.

The operational factors which were identified as deficiencies during this investigation were generally known and accepted by the local CAA agents prior to the accident. Recognizing that the responsibilities of the CAA were not fully discharged, the Administrator took action to correct the local situation at Boston. He also established an inspection process whereby closer supervision can be maintained over the effectiveness of all local CAA offices throughout the country.

INVESTIGATION

Northeast Airlines Flight 258 is a scheduled operation which originates at LaGuardia Airport, N. Y., and terminates at Martha's Vineyard, Mass., with one intermediate stop serving Nantucket, Mass. The flight is scheduled to originate at 2020 and arrive Nantucket and Martha's Vineyard at 2128 and 2210, respectively.

On Aug. 15, 1958, the flight crew assigned to the operation consisted of Capt. John T. Burnham, First Officer David C. Carey and Stewardess Arlene Dabek. Following routine preparations by the crew, the flight departed LaGuardia at 2225 with 31 passengers, including one infant. Departure was about two hours late, which was attributed to cumulative traffic and ramp delays encountered by earlier flights using the aircraft, Convair 240, N 90670.

Weather information pertinent to the route indicated that at departure visual flight rules (VFR) weather conditions existed but that by the time the flight reached Nantucket fog might necessitate an instrument approach. Accordingly, the flight departed VFR but on a dispatch release and flight plan which authorized instrument operation, if necessary, on this contingency. Boston was designated the alternate airport.

At takeoff the gross weight of the aircraft was computed to be 38,478 lb, with the maximum allowable 40,300 lb. The load was properly distributed according to the center of gravity limitations of the aircraft. Computations also showed that upon reaching Nantucket the existing wind conditions and weight of the aircraft, 37,002 lb, permitted landing on the usable length, about 3,800 ft., of runway 24.

Flight 258 operated over Victor Airway 46 to Nantucket. Investigation showed that while en route the flight was in radio communication with the company radio located in the Nantucket terminal building and with Otis RAPCON (Radar Approach Control). The latter is manned by CAA personnel as an Air Traffic Control facility which has as part of its responsibility the control of instrument traffic for Nantucket. It is located at Otis AFB, Falmouth, Mass.

The radio communications between Northeast flights and the company radio are not electronically recorded, although the essence of each is entered in a radio log by the ground communicator. The entry is made in the radio log when the communication is completed and at that time the actual time is noted and affixed to the entry. Operating the company radio and maintaining the radio log are among the duties of Northeast agent personnel and during the evening of Aug. 15 these duties were performed by the senior agent and one subordinate. On its face the log showed several errors and omissions and one time entry was changed, apparently to correct a mistake although the original entry may not have been in error. Because of these discrepancies Board investigators found it mandatory to corroborate the evidence presented by the log before accepting it.

The radio transmissions between flights and Otis RAPCON are electronically recorded. Through "playback" and timing of the tapes it was possible to determine accurately the content of each radio transmission between Flight 258 and this facility as well as the time each communication occurred.

N 90670 was equipped with one VHF communications transmitter and one VHF communications receiver; therefore, Flight 258 could not communicate with Otis RAPCON and Nantucket company at the same time. This fact, and learning that the Northeast and Otis clocks were in accord, made it possible to compare the times of the Otis communications with the time entries in the radio log.

Because weather information given the flight was very important, comparisons were made between the recorded observations by the Weather Bureau and those recorded as having been furnished the flight. Further, the times of the observations were compared with the times they were passed to the flight.

During this work it was learned that the Weather Bureau clock was one minute faster than the Northeast and Otis timepieces. To avoid confusion this error has been eliminated in this report and the times indicated are corrected to the Northeast clock.

Analytical Comparison

Comparisons were made for analytical purposes using the times from the Otis tape, the Northeast log and the Weather Bureau log. In addition, the essence of the transmissions, the sequence of the transmissions, the testimony regarding the events and the time involved in the VOR approach were all painstakingly compared to establish or refute the accuracies of the times entered in the radio log. The preponderance of this evidence sustains the accuracy of the time entries, especially the portion of the log kept by the senior agent beginning at 2328.

It was the testimony of a Northeast agent that the initial contact between Flight 258 and Northeast radio occurred about 2314 when the flight asked for the Nantucket weather.

He stated he transmitted the 2259 hourly sequence report which was: scattered clouds, 500 ft., ceiling 12,000 ft., broken, visibility 4 mi., fog.

The agent stated that at this time the senior agent took the microphone from him and in essence advised the flight that this weather report was obsolete and according to a special report of 2311, the weather was "partial obscuration, three-fourths mile fog." The agent stated that during this communication the flight also requested the strobe lights[3] he turned on. Transmission of the special weather report was logged at 2311 and although the information was acknowledged according to the agent this was not reflected by the radio log. The agent stated he requested the strobe lights he turned on by the CAA communicator who controlled the lights.

At 2314 the flight contacted Otis RAPCON and according to the recorded

[1] All times herein are Eastern Daylight based on the 24-hr. clock. Distances are nautical miles and altitudes are above the ground.

[2] The term CAA (Civil Aeronautics Administration) rather than FAA (Federal Aviation Agency) is used herein because this incident occurred prior to Dec. 31, 1958.

[3] Two condenser discharge flashing approach lights located in the approach zone 250 ft. from the threshold lights, one on each side of the runway edge extended.

conversation advised Otis it was "visual" and past the Newport intersection (located 50 mi southwest of Nantucket on Victor Airway 46) at 2312. The flight requested an instrument approach clearance to Nantucket estimating it would reach Nantucket at 2326.

The clearance was issued at 2315.

About 2324 Flight 258 advised Otis it was going to company frequency for "the altimeter, etc." The company radio log reflected that information as to the active runway, surface wind and altimeter setting was given the flight and logged at 2314. Investigation showed this time was entered following an erasure and that the time originally affixed was 2326. Because at approximately 2324 the flight stated it would request the information from the company it would seem the time entry of 2314 should have been 2326 as originally fixed. Further, because the CAA communicator who turned on the strobe lights testified it was done during the five-minute period preceding 2330, it is entirely probable that the request for lights occurred when the flight requested other landing information rather than during the previous communication. Certainly an inbound flight would request the lights and landing information more logically two or three minutes rather than 14 min. before an instrument approach.

From investigation and testimony obtained at the public hearing it was indicated that the senior Northeast agent did not know the current operating status of the strobe lights or, in particular, that one which had been inoperative was repaired earlier that day. Also, there was no defined procedure for informing ground personnel of the current airport field conditions. In fact, it was not clear to the working ground personnel how or by whom the day-to-day field inspection was made. Also it was not clear how the working groups would learn of pertinent field conditions and the procedure for passing such information between shifts was ill defined.

The transmissions over the company radio were amplified, however, during periods of IFR conditions and when one flight was at the terminal a heavy workload would occur which could result in the radio being left unguarded. Similarly, weather information passed over the intercom could be missed and unknown to Northeast personnel until the Weather Bureau observer, according to procedure brought it in typed form to the Northeast office.

It was the testimony of the senior Northeast agent that he gave Flight 258 a special weather report of "partial obscuration one half mile visibility, fog." This observation according to the Weather Bureau observer and Weather Bureau log was completed and logged at 2327 and immediately given Northeast over an intercom system. The senior agent stated he transmitted it to another Northeast flight, 2289, which was awaiting takeoff and to Flight 258. The time affixed to the radio log entry was 2328. The log showed an acknowledgment from Flight 2289 but not from Flight 258.

The senior agent stated acknowledgment should have been recorded because he was very positive the information was received and associated it with a personal conversation between First Officer David Carey of Flight 258 and himself. This conversation

was overheard by several persons near the radio room, the transmissions being normally amplified by the radio equipment. The senior agent testified that after giving the one half mile visibility he said "Did you get that half mile Dave?" First Officer Carey replied "Roger, you know how I love Nantucket." The senior agent responded, 'Don't plow up the field.' The senior agent said this conversation was uncalled for and to him had no significance. He said that he recognized First Officer Carey's voice and added that Carey had worked on the Island for Northeast and they were personal friends.

Northeast Flight 2289 left the Nantucket terminal about 2321 and taxied to runup position beside runway 24. The captain recalled asking the company for the latest Martha's Vineyard weather. To this Flight 258 volunteered that Martha's Vineyard would be no problem and then asked, 'How's it down there?' The holding flight replied "Not too good." The captain testified that he recalled Flight 258 being given 'partial obscuration, three-fourths mile" and that it was acknowledged. He stated that thereafter he recalled visibility reports from the company radio of one-half mile, one-fourth mile, and one eighth mile.

Captain's Statement

These, he said were given in rapid sequence and he recalled no response from Flight 258 for any of them. The captain stated the reports occurred after his flight reached runup position, about 2324, and thought the accident and one-eighth mile report occurred close together but could not recall which occurred first. He did not know the time of the accident nor was he able to state with accuracy the times of the other events which occurred or the sequence in which they happened.

According to the Otis RAPCON transcription at 2327 Flight 258 did not respond to a call from Otis but before 2328 returned to the Otis frequency. At 2328 in response to an inquiry Flight 258 stated it had not started procedure turn but was "... just past the marker outbound." There after at 2330 the flight transmitted "and Otis this is Northeast 258... procedure turn." Otis responded, 'Roger Northeast 258 change to company.' There were no other communications between the flight and Otis.

At 2330 special observation number 21 was logged by the Weather Bureau observer as "partial obscuration, one-eighth mile visibility, fog." This was given Northeast immediately according to the observer, and it was the testimony of the senior Northeast agent that he promptly transmitted it to Flight 258. He stated he gave the information twice with a substantial pause between each transmission and while there was no verbal response from Flight 258 he recalled a sound over the radio which he thought was a "mike click." He said the sound followed each of the two transmissions of one-eighth mile visibility.

The captain of 2289 did not hear this sound nor did he click his microphone. The senior agent estimated that the action occurred during a 60-90 sec interval before he logged it at 2333. He also stated that at no time was a one-fourth mile visibility report given over the radio. Examination of the Weather Bureau observation log re-

flected no one-fourth mile observation and the Weather observer stated he made no such observation.

The senior agent testified that the next occurrence was a report of a fire in the approach area to runway 24. This was transmitted by Flight 2289. The agent testified he stepped outside, looked toward the area, and because of the fog saw nothing. He then returned and logged the report at 2336 which he estimated was about one minute after the report was transmitted to him.

The Nantucket Memorial Airport is located on the south central side of the Island. It has no tower and is equipped with two crossing runways. Each is 4,000 ft in length and 150 ft wide although at the time of the accident runway 6–24 was being extended to 5,000 ft. This work at the southwest end restricted the usable length to approximately 3,800 ft. The airport has a regular clear green, medium intensity, 3,000,000-candlepower rotating beacon.

Runway 24 is the instrument approach runway. There is no ILS (Instrument Landing System) or ladder-type approach light system. The instrument runway, as well as the others is equipped with conventional threshold lights and medium intensity elevated runway lights of low, medium, and high intensity settings.

The strobe lights previously noted were designed as a visual lighting aid to the instrument approach. They were installed by Northeast Airlines after considerable testing for this purpose. The condenser discharge lights were located 250 ft from the threshold lights, 150 ft apart, in the approach area. They flash two times each second emitting a beamed white light rated at 10,000,000 candlepower.

Technical Witness

A technical witness stated the beam was projected into the approach zone at an angle of 3.4 deg above horizontal so that the lower side of the projected beam would be 300 ft above the ground over the "H" facility located six-tenths of a mile from the runway threshold. This position and altitude would be coincident with the approximate position of an aircraft at minimum altitude during the instrument approach.

The witness stated what below the projected beam the light diminished rapidly and estimated it would be diminished 75% approximately 50 ft below the lower edge of the beam.

The record indicates that the strobe lights were on several minutes before the accident and clearly shows that airport beacon, threshold lights, and runway lights were on, the latter set to high brilliance.

The reported weather conditions required that Flight 258 execute a straight-in VOR instrument approach. For the procedure the ground radio facilities consisted of the VOR station located 1.9 mi from the runway threshold and a Northeast-owned and maintained "H" facility (a low power non-directional radio beacon) positioned six-tenths of a mile from the threshold of runway 24 between the VOR station and runway on an inbound track of 240 deg. The maneuvering area for the approach is over relatively flat unobstructed terrain with the elevation of the runway 47 ft. mean sea level.

The CAA approved VOR instrument approach procedure required establishment of a 60-deg outbound track after station passage. This is followed by a standard procedure turn on the north side of the track within 10 mi of the VOR station. Minimum altitude in the procedure turn is 1,300 ft.

An inbound track of 240 deg. is then required to again cross the VOR station and "H" facility to the runway. Minimum altitude over the VOR is 600 ft after which descent is permissible to the appropriate landing minimum altitude. Flown in a normal manner the approach procedure from the VOR station outbound to the VOR station inbound requires about five minutes. In the Convair about 55 sec are required from the VOR to the runway threshold.

The basic weather minima for the VOR straight-in instrument approach at Nantucket are ceiling 400 ft, visibility one mile. According to the CAA Form 511, with both the VOR and "H" facility in operation, the minima for Northeast Convair flights are ceiling 300 ft and visibility one mile.

CAA witnesses testified that these minima were the result of a deviation authorized by the CAA after the carrier requested it. It was stated that such deviation is provided for in Civil Air Regulations and because it required no significant deviation from the approach obstruction criteria, it was permissible for the local CAA office to grant the request. After consideration of many factors involved this was done.

It was explained that the carrier was authorized the "Sliding Scale" which is a provision of the Operations Specifications applicable to the straight-in approach. Operations Specifications are rules of particular applicability prepared and issued by the Civil Aeronautics Administration under the enabling provisions of Part 40 of the Civil Air Regulations. Under "Airport Authorization and Limitations" it is stated "For each increase of 100 ft above the minimum ceiling specified a decrease of ¼ mi in visibility is authorized until a visibility of ½ mi is reached." Because at the time of the accident a partial obscuration, which does not constitute a ceiling was reported, the 'Sliding Scale" was therefore applicable to Flight 258 and it was authorized to make the approach in ½ mi visibility. The authorized minimum altitude of 300 ft was unaffected by the "Sliding Scale" provision.

It is important to note the responsibilities required of the pilot involved when below minimum weather conditions are reported to a flight during an instrument approach.

Civil Air Regulations Part 40, Section 40.406(d) is applicable and states: "If an instrument approach procedure is initiated when the current report prepared by the U. S. Weather Bureau or by a source approved by the Weather Bureau indicates that the prescribed ceiling and visibility minimums exist and a later weather report indicating below minimum conditions is received after the airplane (1) ... (2) is on a final approach using a radio range station or comparable facility and has passed the appropriate facility and has reached the authorized landing minimum altitude (3) ... such approach may be continued and a landing may be made in the event weather conditions equal to or better than the prescribed minimums for the airport are found to exist by the pilot in command upon reaching the authorized landing minimum altitude."

Except under the aforestated conditions the approach should be discontinued. Obviously, to meet the terms of this regulation the below minimum weather report must be received by the pilot.

The conditions necessary for a descent below minimum altitude during an instrument approach for landing are stated in Air Carrier Operations Specifications, Item 32 of these rules under "Limitations on Descent Below Authorized IFR Landing Minimums" states, 'No aircraft shall descend below the minimum altitude for landing specified in the applicable Form ACA 511 unless clear of clouds. Thereafter, except when landing minimums of 1000-2 or better are authorized, no aircraft shall descend more than 50 ft below such altitude unless (1) it has arrived at a position from which normal approach can be made to the runway of intended landing, and (2) either the approach threshold of such runway or the approach lights or other markings identifiable with such runway are clearly visible to the pilot. If, at any time after descent below the clouds the pilot cannot maintain visual reference to the ground or lights he will immediately execute the appropriate missed approach procedure prescribed in the applicable Form ACA 511.'

The testimony of Northeast supervisory operational personnel indicated that "other markings identifiable with such runway" need not be located at the runway threshold and need not be markings which are part of the runway threshold complex.

Company witnesses stated it was their interpretation that the markings should be of a permanent immobile nature and named as examples "a city dump, a swath through trees and a distinguishing feature of a shoreline."

It was the testimony of CAA Air Carrier Safety Agents associated with Northeast that only markings located at the threshold area of the runway which were a part of the threshold complex could be considered "other markings identifiable with such runway."

Unsatisfactory Interpretation

These witnesses indicated the Northeast interpretation was unsatisfactory to them and until the hearing were unaware of the Northeast interpretation. From all the testimony surrounding the subject it was obvious that the wording of the specification did not state a clear meaning.

Investigation disclosed there were several 55-gal drums spaced along the extended centerline of runway 24. The drums were spaced along this line for a distance of 1,700 ft beginning at the "H" facility and extending toward the runway. The tops of the drums were painted white. The testimony of Northeast officials indicated the drums were put there at the instance of the company in 1953 and originally extended from the "H" facility to the runway threshold but those which originally were located over the last 1,800 ft were removed to satisfy a problem they created relating to use of the land.

Company witnesses stated the barrels were intended to identify a ground position over terrain which had no other distinguishing features or contrast.

It was the testimony of the assistant chief pilot that the barrels were not intended to lead the pilot to the runway threshold and

that it was doubtful if the barrels could be seen at night, especially in poor visibility. Company supervisors also stated the barrels did not qualify as "other markings identifiable with such runways" because they could be moved and thereby lacked the permanence required. It was stated that no operational aspect of the instrument approach procedure was predicated on the barrels. The assistant chief pilot did not recall any company material issued to its pilots explaining the purpose of the barrels or that the installation had been made. He stated, in response to questions that it was conceivable a pilot might use the barrels as a guide to the runway in poor visibility or might consider them as "other markings."

Several persons located at the Nantucket Airport terminal saw Flight 258 when it initially arrived over the vicinity of the airport. Most stated this occurred a few minutes before the crash and that the aircraft was viewed through breaks in heavy fog flying on an easterly or northeasterly heading.

Another witness, a highly qualified pilot and thoroughly familiar with the VOR instrument approach procedure, also saw the flight. He was located about 1½ mi. west of the airport. He stated that he recognized the aircraft as a Convair and when he first saw it it was on an easterly heading.

While he watched the flight turned left to a northeasterly heading and proceeded toward the VOR station. He said the flight at this time appeared to be intercepting the 60 deg. inbound radial. Being familiar with the location of the VOR station he estimated that the flight overloaded the facility. He discontinued watching as the aircraft proceeded northeasterly toward the procedure turn area. He testified that it was evident that the instrument approach procedure was in progress and surmised that instrument weather must have existed at the airport although at his location the weather was clear. The witness stated that the aircraft was clearly visible and it looked and sounded normal.

Several persons located northeast and northwest of the VOR station saw the aircraft. Most observed it casually and stated it was then flying southwest toward the airport. One, located about 1½ mi. northeast of the VOR, stated the aircraft seemed low and estimated it to be about 200–250 ft. above the terrain. Nearly all said it looked and sounded normal, and again the weather conditions in this area were described as generally clear.

There was no reliable description of the flight path of the aircraft from the area of the VOR to the crash.

Witnesses at the terminal, about one mile from the crash site said that fog became evident at the airport about 2300 and thereafter until the crash it became very dense. The fog was described as sea fog which moved in from the ocean in layers and waves. It moved northeasterly from the ocean across the airport into the approach area of runway 24. Some noted the lights of Flight 2289 which was waiting takeoff about one-half mile from the terminal. They stated these lights were visible a few minutes before the crash but at the time of the accident they were blotted out in fog.

One witness at the terminal said that he

observed the light on rear side of a low fog bank moving with the other fog across the airport. This he said blotted out the lights of the DC-3 (Flight 2789) and was moving toward the approach area. While watching for Flight 258 to land he saw a light appear, the beam of which he said, was triangular, narrow at the top and broad at the bottom. This he thought was the landing lights of Flight 258.

The light appeared only momentarily but it was sufficient to illuminate the fog bank and to outline the right or rear side and the top; the latter was estimated to be about 200–250 ft above the ground. He said the light emanated from behind or from within the fog bank.

Several others saw a light, however they described it as an explosive-like flash at ground level.

The description of the weather conditions by the weather observer on duty did not differ substantially from the description given by ground witnesses. He noted that stars were visible through breaks in the fog and estimated the fog was about seven-tenths coverage at 2311, increasing to nine-tenths coverage at 2330. He stated that when he took the one-eighth mile observation he thought the fog seemed fairly uniform and at that time he did not note a fog bank as such, but being outside only for a short period he could have been in it at the time.

The observer said that in his experience it was not unusual to have a heavy fog at the airport with the surrounding areas generally clear. The observer testified that in measuring the one-eighth mile visibility there were references which showed the visibility to be equal to this value and not less. He said, however, that measuring visibility at Nantucket was hampered by the lack of reference in all quadrants and at varying distances.

The weather observer testified that according to Weather Bureau procedure after physically obtaining the observation data he returned to the office where it was recorded in the Weather Bureau log. He stated that the time affixed in the log was observed at or near the completion of the recording and immediately the information was passed to Northeast over the intercom. He said their normal procedure was then to type the observation and give it to CAA for teletype transmission. The witness said this procedure was followed on the night of the accident and estimated that no more than 15 sec transpired from the log entry time of his observation until it was passed to Northeast.

According to the existing Weather Bureau procedure at the time of the accident, special weather reports were teletyped to Otis RAPCON at the scan periods (20 and 40 min past the hour). Special weather observations between these periods were not available to this control facility although Northeast flights were in communication with Otis during important phases of the instrument approach and, as noted, when communication with the company was precluded.

Witnesses at the public hearing agreed that all important weather reports should be available immediately to Otis so they could be furnished to a flight when on the Otis radio frequency.

A similar situation existed with respect to the transmission of weather information

to the Boston Northeast dispatch office. This, it was stated, resulted in a lack of timely weather information and hampered in some degree the execution of dispatching responsibility.

Investigation at the accident scene disclosed that N 90670 initially contacted the ground approximately 1,450 ft short of run way 24 and about 650 ft to the left (inbound) of the extended runway centerline. The initial contact was shown by light tire tracks made by the tires of all three landing gear components. The lightness of the tracks in soft ground showed the aircraft had little, if any, rate of sink or descent at initial contact.

Tracks Studied

Because all the tracks began nearly simultaneously, it was also evident that the aircraft was nearly level laterally and longitudinally. Tire tracks by all landing gear components continued for about 145 ft along a magnetic heading of 233 deg. and over bumpy but flat terrain which averaged about 50 ft. mean sea level.

There was a series of 14 left propeller cuts in the ground across the left tire tracks, beginning after about 50 ft. of rollout and spaced over a distance of 100 ft. The first three cuts, about three to four inches deep, were well defined and the distance between the first and second cuts was 41 ft. The later slashes were of lesser depth and about equal in width to the blade chord showing that the blades were being treated and bent rearward as the cuts progressed. Obviously, such deformation destroyed the propeller function.

The wheel tracks ended after about 145 ft. when the wheels contacted a sharp but not high rise in the ground and the aircraft catapulted into the air. It crossed a dirt road and passed through a clump of scrub pine trees.

A branch of one of these trees was marked by a blade of the right propeller. Examination of the cut showed it was made at the bottom of the propeller arc and by the tip of a blade.

This information and the height of the mark showed the aircraft was rolling rapidly left at this point.

Approximately 400 ft. from the initial ground contact the left wing struck the ground and progressively disintegrated as it dragged for the next 300 ft. The aircraft entered a scrub pine thicket cutting a swath the narrowness of which showed the aircraft was then nearly vertical in its roll axis.

Magnetic Heading

The aircraft veered left to a magnetic heading of 190 deg. and reached an attitude slightly past inverted. Nose down in this attitude the aircraft plunged to the ground making simultaneous contact with the right wing and powerplant and the nose section of the airplane. The center section and fuselage then cartwheeled forward to an upright attitude and, on a magnetic heading of 205 deg., slid 125 ft. to a stop, some 1,100 ft. from the initial contact.

The fuselage stopped, facing across the wreckage path and the center section broken from the fuselage during the cartwheel and slide, faced about 90 deg. to the left of the fuselage.

Fuel from the shattered wings was hurled into the main wreckage area and ignited. The resulting fire consumed a major portion of the wreckage.

All major components of the aircraft, including flight control surfaces, were accounted for in the wreckage or along the ground path. All attach fittings were secure or there was ample evidence indicating they were secure before the ground impact. It was determined all doors and access panels were closed and secure at impact. There was no evidence of fatigue failure and from the examinable structure there was no suggestion of inflight failure.

The control system could be traced only from fuselage station 200 rearward because of complete impact and fire destruction to the forward fuselage and cockpit areas. Within the examinable area there was no evidence of control malfunction or failure.

Examination of the landing gear components disclosed the right main gear was retracted and locked. It also revealed the left main and nose gears were in the retraction cycle when early impact forces severely damaged the retraction mechanisms and tore off the nose gear. Later in the sequence the left gear was also torn off. Examination of the flap gear box showed the wing flaps were extended about 15 deg. when the aircraft came to rest.

Both powerplants were in the main wreckage area. The No. 1 (left) powerplant was torn out and came to rest adjacent to and facing the center section of the aircraft. The No. 2 (right) engines, also torn out, was located back along the wreckage path about 40 ft. from the main fuselage.

The nose section and propeller were broken off and located about 75 ft. from the engine. Both engines received ground fire damage, however, there was no evidence of fire in flight. A detailed examination revealed no indication of engine malfunction or failure or other conditions which would adversely affect their normal operation prior to impact.

Propeller Examination

Both propellers were tight on their shafts and although all blades were bent or broken the blades or stub ends remained in their hubs. Examination of the spider shim plates revealed impact markings. These, when measured to determine the propeller blade angles, disclosed an angle of 37 deg. for the left propeller blades and an angle of 43 deg. for the right.

The propeller governors were bench checked to ascertain the rpm. settings. Results showed settings of 2,330 and 2,362 for the left and right governor, respectively, and closely approximating 2,300 rpm. normally used during the approach.

Using an rpm. of 2,330 and the distance of 41 ft. between the first and second propeller slash in the ground, the resulting computation of groundspeed for the aircraft when the cuts were made was 126 kt. This allowing for the effect of the reported surface wind, indicated an airspeed of 131 kt. Further computations using the groundspeed, propeller blade angles, and rpm. permitted an estimate of power being developed at the instant the shim plates were marked for the left engine when its propeller slashed the ground and for the right engine at final impact, or approximately five seconds later.

The resultant estimates were 1,342 bhp. (brake horsepower) and 2,450 bhp. for the left and right engines, respectively. The values also approximate approach power for the left engine and maximum power for the right.

Nearly all of the radio communications and navigational equipment sustained severe and extensive impact damage. In some instances only fragmentary portions of this equipment were recovered.

The VHF (very high frequency) communications transmitter and receiver and the HF (high frequency) transceiver were destroyed. Both VHF navigation receivers were crushed and inoperative, however, the tuning dial for the first officer's was found indicating 117.0 mc., the Nantucket VOR frequency. The captain's tuning dial showed 115.4 mc., an unrelated setting. Both omni bearing indicators showed approximately 60 deg.

Omni Mag Indicators

Both omni mag indicators were badly damaged, inoperative and could not be tested. Reassembly of the course selector gears of the captain's instrument revealed a course selection of 240 deg. The 'To-From" indicator indicated "From." The comparable instrument from the first officer's position showed a course selection indication of 24, the last digit obliterated. It may be recalled that the inbound track of the instrument approach is 240 deg.

After replacing broken tubes the first officer's ADF (automatic direction finder) was operable but with low sensitivity. The captain's was damaged beyond repair. The tuning condensers showed 244 kc. and 236 kc. for the left and right positions, respectively, however, both showed evidence of having been pulled and shifted by impact. The "H" facility frequency to which at least one of these units would normally be tuned is 224 kc.

Of the gyrosyn instruments, the two gyrosyn compasses and one of the two gyrosyn amplifiers were recovered. One of the compasses, though badly mutilated by impact and fire showed an indication of 190 deg. which closely approximated the final ground impact heading. The other compass provided no useful information. The amplifier when checked functioned normally.

The top plate assembly from each of the two flight altimeters was recovered although its installed position (right or left) could not be determined. Both assemblies were badly crushed and burned and partially melted away. Using the fragmentary evidence available it was concluded that one altimeter was set at 29.92 and the other at 29.65 when both were subjected to intense fire. There was evidence indicating that an object was thrown against the setting knob of the latter assembly causing it to turn and change the setting before being exposed to the fire. The latest altimeter setting furnished the flight was 29.91.

During the public hearing the company's vice president of operations and the assistant chief pilot described the company's operational policies and procedures relating to initial pilot selection, pilot training and upgrading and continued pilot proficiency. In general the testimony described policies and procedures which intended a program within their areas comparable to those of other air carriers. In some areas, however, the adequacy of implementation of the program

and consequently its effectiveness was questionable

Concurrently with the accident investigation the CAA undertook an operational inspection of the carrier It was undertaken under the CAA responsibility for the supervision of air carrier operations and was prompted by three fatal accidents experienced by the carrier since 1956 The inspecting team was composed of several air carrier safety inspectors other than those assigned to the Boston office It functioned under the Regional Administrator

The accident investigation by Board investigators and the conclusions reached by the CAA team were similar in several areas, some of which have already been presented Of other areas one of the most important was operational training which was considered inadequate the result of several factors

Testimony of Northeast witnesses indicated that the use of Northeast aircraft in the scheduled operations took priority over their use in training Board investigators determined that at times this resulted in interruptions of the training function and reduced the over-all effectiveness of the program The CAA team concluded that inefficient scheduling of aircraft over the system reduced the availability of aircraft for training Lack of training personnel also contributed to the problem

The CAA team indicated that undesirable factors in the pilot check program contributed to the evaluation It concluded that there was a need for greater standardization of flight check procedures among the check pilots and more explicit instructions to them regarding their duties and responsibilities The team concluded that supervisory personnel needed delegated authority commensurate with their positions Allied to the check program was a requirement for greater stress on the importance and use of recurrent training

During the CAA inspection, Northeast captains received flight proficiency checks The results substantiated the conclusions of the team when a number of these pilots were graded unsatisfactory on their first check

It was the testimony of the local CAA air carrier safety inspectors having responsibility for the supervision of the operational phases of the carrier that in general, they were satisfactory Obviously this judgment was not in accord with the CAA inspecting team

During the accident investigation Board investigators found it difficult to determine, from the available company records, some of the current qualifications of line pilots It was learned that some of the information on which the company relied was submitted by each pilot rather than being obtained from the record system

ANALYSIS

Available evidence indicates that except for a late departure Flight 238 operated in a normal manner to Nantucket. Position reports, requiring the use of navigational equipment and other communications from the flight gave no indication of operational or equipment difficulty Although portions of the aircraft wreckage were destroyed or badly mutilated no evidence was found to indicate the aircraft or its equipment contributed to or caused the accident

It is believed that at or about 2311 the

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flight was given the Nantucket 2311 special weather observation of partial obscuration visibility ¾ mi." This is supported by the Northeast agent who stated it was given and by an appropriate entry in the Northeast radio log. Receipt of the information is supported by action of the flight when shortly thereafter, at 2314, it contacted Otis, asked for and received an instrument approach clearance. Because the flight had operated VFR before this and reported it was "visual" when the clearance was requested it would be logical to assume the crew knew IFR conditions existed at Nantucket and therefore requested the IFR clearance.

As indicated earlier, the Board is of the opinion that the landing information given the flight and logged as being given at 2314 was in fact given just before 2326 the original entry. This opinion is supported by several factors. First, Flight 258 informed Otis at 2324 it was going to company frequency to obtain this information. Second, logic dictates that such information would normally be requested by an inbound IFR flight two to three minutes before an instrument approach rather than 14 min. This is especially true in determining and maintaining weather conditions which existed. Furthermore, for these reasons the Board believes the surface observation would be requested again or would be given as a matter of practice by the radio operator with the landing instructions. Therefore in all probability the partial obscuration visibility ¾ mi report was reported at 2326. This would account for the crew of Flight 2289 having heard this report given to Flight 258 about that time.

There is no question that the special observation of "partial obscuration ¾ mi visibility" was transmitted by the Northeast senior agent. Because the crew of Flight 2289 did not hear an acknowledgment and the radio log did not reflect one there was a question of whether or not Flight 258 was on the company frequency when the weather information was transmitted.

This information was available to the senior agent immediately after 2327 and according to his testimony it was immediately given to the flight. This was completed and the action was logged at 2328. The Otis tape shows that Flight 258 did not return to that frequency until 2327:40, therefore the Board is of the opinion the flight was on company frequency when the weather report was issued. This analysis permits the Board to accept the recollection of the senior agent which should have been most vivid recalling the personal conversation that transpired between himself and First Officer Carey when the one half mile visibility report was issued.

A question of even greater concern is whether or not Flight 258 received the special weather report of "partial obscuration, visibility ¾ mi" and, if so, when the report was received. This concern is generated because the reported visibility was below the authorized landing minimum for the flight; if as has been explained, the report was received before the flight reached the radio facility on final approach the captain was required to discontinue the instrument approach. After arduous study and careful evaluation of all the evidence it is the opinion of the Board that the report was re-

JT12 Installed on Flying Testbed

Pratt & Whitney JT12 turbojet engine powerplant for the Lockheed Jetstar, McDonnell 119 and North American Sabreliner, has completed flight tests on this North American B-45 jet bomber. The engine, which weighs 430 lb and produces 3,000 lb thrust (AW Feb. 2, p. 27), can be equipped with afterburner for military operations increasing weight to 645 lb and thrust to 3,900 lb. Engine also will power SD-4 drone manufactured by Republic Aviation Corp. and Fairchild Engine & Airplane Corp.'s SD-5 drone.

received and at a time when the approach should have been discontinued. This opinion is based on a determination of the time of the accident and again upon the accuracy of the Northeast radio log. Each of these supports the other and the Otis tape supports both.

At 2328, according to the Otis tape, the flight reported "We're just past the marker outbound" and at 2330 it reported "Procedure turn." These reports and ample evidence that the entire approach procedure was flown would place the accident very close to 2334. This time correlates reasonably to the report about 2335 from Flight 2289 that there was a fire at the end of the runway, which the senior agent recorded at 2336 after using approximately one minute to look for the reported fire.

The time of the accident also substantiates the accuracy of the radio log. Its accuracy is further established by the fact that at 2330, according to the Otis tape, Flight 2289 was advised to obtain its clearance through the company and, according to the radio log, this action was completed and logged at 2331. For this action the various times involved correlate in a precise manner.

From the above evidence the Board accepts as accurate the log entry and the testimony of the company agents regarding the issuance of the below minimum weather report. Testimony of the senior agent indicates the information was transmitted two times during a 60-90-sec. interval preceding 2333, when the action was completed and logged. Correlated to the timing of the approach procedure, Flight 258 would not have passed the VOR inbound and, more specifically, should have been in its procedure turn when the information was first transmitted. Because Flight 258 was released from Otis to company frequency at 2330 and because each transmission of the 4 mi. visibility was followed by a sound identified as a mike click, the Board believes the information was received.

The nature of the local weather conditions may have been a factor in Capt. Burnham's decision to continue the approach. From the available evidence it is apparent that a heavy rolling sea fog extending to at least 300 ft. existed over the airport and into the approach area. It is believed that the fog was very heavy to the "H" facility, rapidly decreasing in density northeastward until in the area of the VOR the conditions were generally clear. It is possible that as Flight 258 passed over the vicinity of the airport lights on the airport were clearly visible vertically through the fog. This together with generally clear conditions in the VOR area, could have led the captain to believe weather conditions were much better at the approach end of runway 24 than at the terminal where the conditions were being measured.

The approach was most likely continued inbound with reference to the ground and by the time the flight reached the "H" facility it was at a low altitude. The low altitude is shown clearly by the light touchdown of the aircraft and the short distance from the "H" facility to the touchdown.

Considering the distance, the computed groundspeed and that practically all descent had been arrested at touchdown, only an excessive rate of descent would permit the flight to have passed the "H" facility much above 100 ft.

At this altitude and position the Board is convinced that intervening fog between the flight and runway threshold precluded visual reference to the threshold complex. This is clearly substantiated in that the ground tracks of the aircraft were proceeding away from rather than toward runway alignment. It is considered that the relatively short runway may have influenced the descent to low altitude and it is possible that a desire to pick up and follow the line of barrels was a contributing reason.

At low altitude in the area of the "H" facility it is believed that the flight entered the heavy fog bank described by an eyewitness. It is believed that at this time all ground reference was lost and before transition to instruments could be made and the approach discontinued the remaining altitude was lost and the aircraft contacted the ground.

CONCLUSIONS

To this report the Board has entered criticism of some of the Northeast operational policies and procedures and of the implementation of the operational program. The criticisms are the product of a combined effort—the Board's accident investigation process and a CAA inspection, both of which had the cooperation and assistance of Northeast personnel. The work was accomplished with a common purpose of producing greater aviation safety through improvements wherever possible.

Following the accident the company believed it advisable to discontinue the use of the "Sliding Scale" at Nantucket for a period of re-evaluation. In the absence of an ILS and ladder type approach lights and in consideration of the authorized deviation this action appears wise.

With reference to the ILS and approach lights the Board, through meetings with the CAA and the Weather Bureau, has learned that the installation of a tower, ILS approach lights and "end of the runway" electronic weather reporting equipment at Nantucket is being actively considered. Such installation would be in accordance with provisions of the CAA planning standards allowing for the installation as an exception to the general requirements.

Many factors in the Nantucket situation qualify it as an exception. Installation of "end of the runway" weather reporting equipment would be in accordance with a Weather Bureau policy to install this equipment as part of the ILS package. Obviously the above action would be a significant step toward modernization of the airport.

In the meantime and following the accident the Weather Bureau took measures to provide Otis RAPCON with all weather observations taken at Nantucket during IFR conditions.

From the considerable testimony regarding the correct interpretation of Item 32 of the Operations Specifications (Limitations on descent below authorized IFR landing minimums) the Board believes that the best operating policy clearly requires adherence to the CAA interpretation. In order to effect its interpretation and because the interpretation is not clearly expressed, the Administrator is presently considering a revision to the language of Item 32.

The company has taken positive steps to eliminate deficiencies in its operational training program which were disclosed in the

Board's accident investigation and the CAA inspection. The foundation of the action was a re-emphasis of the training function under company supervisors with appropriate delegated authority. Accordingly, company policy now requires that the use of aircraft for training receive the highest priority. It also requires that the various training phases and curriculums not be interrupted by controllable factors. An increased emphasis on current training provides that in addition to the existing program each pilot captain will receive a concentrated ground and flight training period preceding each semiannual instrument check.

Through communications and meetings with company officials and the Administrator and his staff the Board has been kept informed of the aforementioned action as well as other allied measures. It has been reported that a determined effort has been made by the company to satisfy each criticism even though in some specific instances the company believes the criticism was not wholly warranted.

The Board believes that rapid and substantial progress has been made and in many instances the deficiencies have already been corrected.

Most of the areas in which deficiencies were found are the subjects of express provisions of the Civil Air Regulations, some of which require approval of the CAA. Under the responsibility of the Administrator all of the areas require his continued scrutiny through his local staff. Obviously, the operational factors which were identified as deficiencies were generally known and accepted by the local CAA agents prior to the accident.

The Administrator, recognizing this, took action to correct the local situation and also to establish an inspection process whereby closer supervision can be maintained over the effectiveness of CAA offices throughout the country having the same responsibilities.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the deficient judgment and technique of the pilot during an instrument approach in adverse weather conditions in failing to abandon the approach when a visibility of one-eighth mile was reported, and descending to a dangerously low altitude while still a considerable distance from the runway.

By the Civil Aeronautics Board:
James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

INVESTIGATION AND HEARING

The Civil Aeronautics Board was notified of this accident shortly after its occurrence and initiated an investigation in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended.

A public hearing was held by the Board in Bennett Hall, Nantucket, Mass., on Oct. 1, 2, and 3, 1958.

AIR CARRIER

Northeast Airlines, Inc., is a Massachusetts corporation with its principal offices in Boston. The carrier is engaged in the trans-

portation by air of persons, property, and mail. The company operates under a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and operating certificate issued by the Civil Aeronautics Administration.

FLIGHT PERSONNEL

Capt. John I. Burnham, age 36, was employed by Northeast Airlines on May 24, 1951.

He became captain Sept. 27, 1956. He possessed a currently effective airman certificate with an airline transport rating and DC-3 and Convair type ratings. Capt. Burnham had accumulated 5,608 flying hours with the company, of which 4,028 were in the DC-3, 165 were in the DC-4 and 1,416 were in the Convair. He had flown the route involved numerous times while copilot and captain and had received a satisfactory route check on June 26, 1958. His latest physical examination was satisfactorily accomplished on Mar. 17, 1958.

Records on Capt. Burnham showed the satisfactory completion of all semiannual instrument flight checks except one which was flown on Oct. 14, 1957, and graded unsatisfactory. Following additional Link and flight instruction a recheck on Oct. 16, 1957, was completed satisfactorily. Both the Oct. 14 and 16 flights were accompanied by CAA inspectors and the checking pilot was the assistant chief pilot. Testimony of these persons indicated the discrepancies were not of a serious nature and following training all were corrected.

First Officer David C. Carey, age 23, was employed by Northeast Airlines on June 27, 1957. He held a currently effective airman certificate with commercial and instrument ratings. He was qualified as a first officer on the Convair on July 30, 1957. At the time of the accident First Officer Carey had accumulated 614 flying hours, 296 prior to employment and 318 during employment, of which 132 were in the Convair. First Officer Carey was on leave of absence to complete college from Sept. 15, 1957, until June 15, 1958.

His latest physical examination was satisfactorily completed May 9, 1958.

Stewardess Arlene Dahek, age 23, was employed by the company on Nov. 25, 1957, and received stewardess training until Dec. 10, 1957.

Miss Dahek received her annual physical examination Nov. 25, 1957. She had flown regular schedules from Dec. 14, 1957, until the accident.

THE AIRCRAFT

N 90670, a Convair 240, was manufactured Aug. 22, 1948, and sold to Pan American World Airways. It was purchased by Northeast Airlines April 24, 1954, and of 18,019 hr. on the airframe, 8,773 were accumulated by Northeast. Since the last major aircraft overhaul N 90670 had flown 1,605 hr.

The aircraft was powered by Pratt & Whitney R2800 CB-3 engines, both of which had operated 1,155 hr. since overhaul. The engines were equipped with Hamilton Standard propellers, model 43E60-89-12. The left and right propellers respectively, had operated 1,870 hr. and 869 hr. since overhaul.

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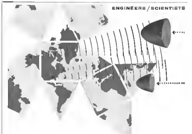

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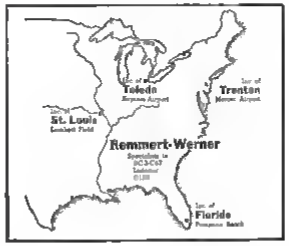

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AVIATION WEEK, MAY 4, 1959

CLASSIFIED ADVERTISING

ADVERTISERS INDEX

LETTERS

Pilot Experience

I ask you quite frankly, what are you trying to prove? The tenor of your publication over the past several months has been a constant derision of the ability, integrity, and intelligence of the airline pilots of this nation.

You do a great disservice to the aviation industry by printing half truths innuendos, and ununiformed opinions which confuse and spread doubt into the minds of the traveling public. If you place no significance on 20 years cockpit experience, 20 000 hr. of day-in-day-out flying, a military record rewarded with this nation's highest honors, or hundreds of hours of research flying just who would you and certain of your readers like to see flying airline aircraft?

Airplanes are machines they are flown by men. Let's not write either one off with malicious slander.

GORDON C. BLANCHARD
Captain, Eastern Air Lines
Marblehead, Mass.

Jeopardized Defense

Some of the criticism directed at you in AVIATION WEEK's Letters section regarding your stand on more adequate defense has left me disturbed. I have waited some time since most of those letters were published in order that I might "cool down." I'm cooled, but I find I still feel like offering a rebuttal.

On the premise that all of the writers had patriotic motives, I found the thing that disturbed me most was seemingly complete disregard for all the lessons of history. One nation does not attack another unless he believes he is stronger and hence can win. Also, in the power politics game that the world is engaged in at the present time, you don't bargain from a position of weakness and hope to come out anything better than second best. For these two reasons alone we must be the strongest, militarily speaking, because as long as the "enemy" has a dictatorial form of government, history as well as the pronouncements of Marx and Lenin tell us that we can expect war when they believe they are stronger.

I'm certainly in favor of a balanced budget, but not at the expense of an adequate defense. I can't help but wonder if your same critics express as loud a cry to their congressmen or local newspapers regarding the appalling waste that goes on every year in stockpiling corn, cotton and wheat. Perhaps they also disregard the myriad welfare programs that the taxpayers bankroll every year. And you certainly can't disregard the huge attendant administrative costs of these schemes!

To paraphrase one of the noisiest of your critics, the President with all of his military background certainly should know whether we have an adequate defense, more so even than a magazine editor. I would be the first to agree, however, the facts as shown by exhaustive studies tell us otherwise. I'm referring to the Gaither Report and a study completed by the Rockefeller brothers. Both of these reports have advocated a program of military spending, the magnitude of which would leave pale by comparison, the funds requested by the heads of the services to bring their branches up to adequate strength. As to whether we can afford this type of defense, one can turn to the conclusion of a study made by the Committee for Economic Development. They reported that this country could spend considerably more for defense than is presently being done without jeopardizing our economic future.

If the leaders of this country don't stop preoccupying themselves with the economics of an adequate defense, the statement that I believe Lenin made that "when we Communists are at last ready to hang the capitalists they will be trying to outbid each other for the right to supply the hemp" will come true.

JACK WARD
Santa Monica, Calif.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Weather Flying

The danger of midair collision has been built up into a horrible bogeyman, constructed of a minimum of fact and a maximum of propaganda.

In order to redress the balance somewhat, I made a summary of CAB reports for the last 11 years, 1948-1958 inclusive, giving the causes of all accidents on our scheduled domestic airlines that resulted in fatalities to passengers.

There were a total of 46 such accidents, two of which were caused by passengers exploding bombs aboard.

Of the remaining 44, six were midair collisions—which sounds very bad until we examine it more closely.

Three of the six were caused by illegal actions on the part of a pilot. (Buzzing a small plane crossing him over a crowded airport without clearance; flying in the overcast without clearance.) Obviously you do not prevent law breaking by making more laws.

Two of the remaining collisions were caused by military training flights along airways. This practice has now been discontinued.

This leaves exactly one midair collision in 11 years and this was not the result of high closure speeds or overcrowded airways or any of the rest of it since both aircraft were piston propelled and the accident took place in one of the most deserted regions of the country.

What the summary shows clearly is that the real killer along the airways is flying in bad weather and if the authorities would do more about that (such as providing radar and ILS to our smaller airports) they would do more good to aviation than in pursuing their present impossible dream of total control.

MARION HART
New York, N. Y.

Radiation Weapons

My letter on the subject of a radiation weapon (specifically a transmutation beam) published in AVIATION WEEK Nov. 25, 1957, p. 126, aroused considerable comment and most of that comment could have been summarized as "Ha ha! What nonsense!"

Are those commentators still laughing after reading in AVIATION WEEK (Mar. 2, p. 18) that the Advanced Research Projects Agency will soon award contracts for the study of such "nonsensical" devices as radiation weapons?

Will they still be laughing when the Russians put a man in orbit on or about May Day, an achievement which will be the first step toward the construction of a manned satellite, the optimum site for a radiation weapon?

Caution and scepticism are indispensable when considering the possibilities opened up by the advance and technology, but God preserve America from those who can only laugh at such possibilities.

The concluding sentence of my 1957 letter is still true: "Thus there is the threat of the satellite, the enemy's ability to bombard the United States with radiation."

ALFRED MACHADO, JR.
New Bedford, Mass.

Satellite Optics

I recently enjoyed your three articles on the series of Satellite Reconnaissance Optics in the Jan. 19, Jan. 26 and Feb. 2 issues. I have referred to these articles several times since receiving the issues.

The issues of this foremost publication in the field of aviation and space form a valuable section of my reference library. As I refer to these articles frequently, I would like to receive a reprint of them so that I will not have to cut them out of my reference issues.

W. E. HORN
Westinghouse Electric Corp.
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Baltimore, Md.

Keep 'Em Flying

Three cheers for Mr. Charles W. Key, Seattle, Wash. (AW Feb. 2, p. 102).

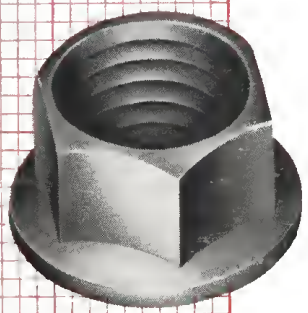
Count one in on the private flying list, too. Granted we all need rockets and missiles for our defense and our pocketbooks, but we can't joyride one on a Sunday afternoon, no matter how much freedom we have. Let's keep the little guy flying and let's keep him in AVIATION WEEK. Anyone else for the band wagon?

JULIAN DOSKOW
Quality Control
Republic Aviation Corp., N. Y.

ESNA gives the design decision to the engineer

If your major consideration is . . .

. . . WEIGHT REDUCTION

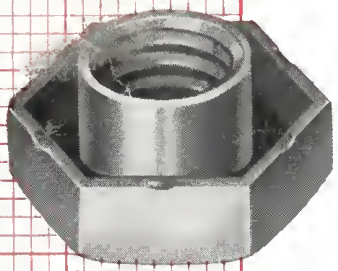


Type LH3324 (160,000 psi)

THIS NEW DESIGN is ESNA's recommendation for applications where space and weight reduction are primary needs. Meets MIL-N-25027; reduced wrenching dimensions permit more efficient centerline bolt design; wrench heights carefully engineered to assure satisfactory assembly line performance. Materials: carbon steel, AMS6304 alloy steel and A286 stainless steel.

wt in lbs per 1000	Screw Size # 4	# 6	# 8	# 10	¼"	5/16"	3/8"	tensile rating
LH3324	.2	.6	1.3	1.4	2.9	5.4	7.3	160,000 psi
NAS679	.9	1.7	2.4	2.6	4.6	6.4	8.6	140,000 psi
AN365	1.4	2.6	4.2	5.0	9.0	12.0	18.0	140,000 psi

. . . USE OF NAS STANDARD HARDWARE

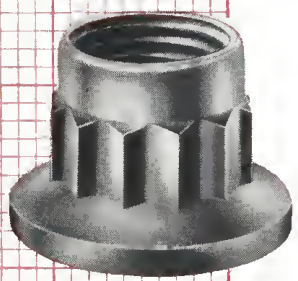


Type LHTE-TM (NAS 679 140,000 psi)

This complete line of low-height, lightweight NAS 679 hex nuts has been designed and produced to ESNA's exacting quality standards. Qualified to MIL-N-25027. External-internal wrenching surfaces for easy installation in limited access areas. Sizes 4-40 through 7/16-20. Alloy steel for temperatures to 550°F; A286 stainless steel for temperatures to 900°F and nonmagnetic applications.

ESNA offers a complete line of ALL NAS types of self-locking nuts, including standard and miniature anchors, floaters and gang channels.

. . . ULTRA-HIGH TENSILE AND FATIGUE PERFORMANCE



Type LH3393 (220,000 psi)

Specify types LH 3393 and LHEB 220 for the utmost in high tensile and fatigue-life performance. Highest strength-to-weight of any available double hex design. Cold-formed from alloy steels; sizes ¼-28 thru 1". For use at temperatures to 550°F.

Other lightweight 12 point nut series are available in several tensile capacities and materials for service at temperatures to 1300°F.

Fit the fastener to the application from the only complete line of self-locking fasteners

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. S36-525, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey
Please send me the following free fastening information:

☐ Complete dimensional and performance data of the new type 3324 nut.

☐ Visual Index: A complete pictorial representation of all standard Elastic Stop nuts.

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